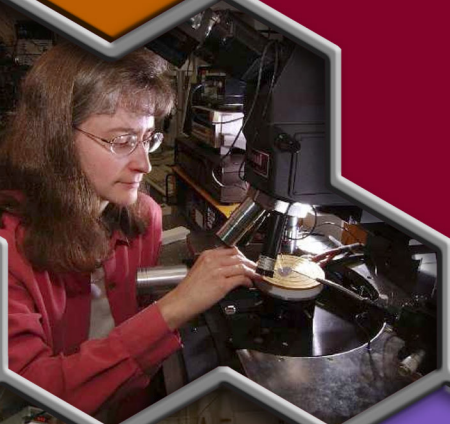


SANDIA NATIONAL LABORATORIES

PARTNERING FOR A STRONG AMERICA



ANNUAL
PARTNERSHIPS
REPORT
FY2004



Sandia
National
Laboratories

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Message From Pace VanDevender, Vice President of Science, Technology, and Partnerships and Chief Technology Officer

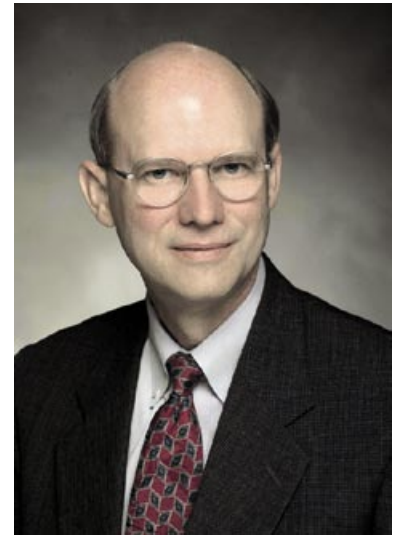
At Sandia, partnering is a fundamental strategy for meeting mission objectives. Through partnerships, we develop new technologies and refine existing ones; we develop commercial sources and provide reliability data for mission programs; we leverage important capabilities and acquire best engineering, business, and program management practices from industry; and we create advocacy and support for Sandia. The knowledge and skills gained through collaborations with industry directly benefit our government customers – the Department of Energy (DOE), the National Nuclear Security Administration (NNSA), the Department of Defense (DoD), the Department of Homeland Security (DHS), and other agencies.

Our industry partners gain as well, through their access to Sandia's exceptional technology base, infrastructure, and staff, and by leveraging the U.S. government's investment in science and technology. Partnerships move Sandia technology from the laboratory to the market to increase U.S. competitiveness and economic strength. In addition, partnerships with industry both diversify Sandia's revenue streams and provide additional sources of invaluable technical expertise (and on occasion, donated equipment) applicable to DOE/NNSA programs. Sandia researchers value work with industry because it is fast-paced, reinforces the relevancy of their work, and has tangible results as technical advancements turn into products.

In December 2004, Sandia's Mission Council reaffirmed the importance of the Partnerships and Business Development organizations in New Mexico and California as crucial enablers for accomplishing Sandia missions. Our goal is to establish technology partnerships that enhance Sandia's ability to fulfill its mission, transfer technology, create jobs, and generate revenues.

Our partnerships program is robust and continues to evolve. Since the early 1990s, when Congress directed that Sandia and the other national laboratories partner with industry, we have matured in our support to Sandia's Strategic Management Units by teaming together to efficiently identify potential strategic partners, execute agreements, and perform research and development to pave the way for incorporating Sandia technologies into cutting-edge products and services.

This edition of our annual report reviews our efforts and successes during Fiscal Year 2004. Our partnering strategies created relationships among Sandia, government agencies, and industry partners to meet the needs of federal and state governments. New technologies were efficiently transferred to industry partners to manufacture products for national security applications. University research partnerships provided innovative technologies. Our licensing of intellectual property created spin-offs and start-ups with Sandia entrepreneurs who left the



Labs under the Entrepreneurial Separation to Transfer Technology program. Our small-business programs and our long-term relationships with leading companies, such as Intel, EMCORE, Goodyear, Lockheed Martin, and General Atomics, strengthened the economy through their commercial successes.

By their very nature, partnerships are relationships with colleagues. We gratefully acknowledge the cooperation of our colleagues within the national laboratories, in universities, other federal agencies, and in industry. We are certain that with their collaboration and support Sandia's partnership activities will continue to be an important vehicle for accomplishing Sandia missions and meeting our national security needs.

Long-term, Strategic Relationships Support Mission Success

Goodyear, Northrop Grumman, and Lockheed Martin join with Sandia in multiple projects that promote national security, corporate profitability. Here are a few of the recent collaborations.

Goodyear Tire and Rubber Company

For decades, DOE has invested in Engineering Sciences at Sandia for application to weapon programs. Through these investments and those of other federal and nonfederal partners, Sandia has developed advanced tools for computational mechanics and reliability engineering methodologies applicable to all aspects of weapons development and manufacturing processes.

Sandia and Goodyear have worked in partnership since 1993. The more than decade-long partnership with Goodyear has included opportunities to:

- develop new capabilities in areas such as computational simulation, microsensors, reliability, chemical separations, etc. for Sandia applications;
- learn about the process of integrating simulation into design and qualification;
- increase the confidence in our computational and reliability tools;
- excite and broaden the experience of our staff; and
- return value to the taxpayer.

The partnership continues to grow, with Sandia and Goodyear now actively working in the following areas; computational mechanics, structural dynamics, information surety, microsensors, manufacturing reliability, and chemical separations.

In 2004, Goodyear took a completely new approach to design, performance evaluation, modeling, and prototype

development for their **Assurance™** product, featuring TripleTread Technology™. Computational modeling and simulation developed in the longstanding partnership with Sandia was a major contributor to the development of the Assurance line of tires in just eight months. The new approach allows optimization over a significantly wider range of parameters in both design features and materials properties within a given development timeframe and budget. The result is a superior product at a competitive cost.

Sandia applies its validated simulation capabilities to DOE/NNSA mission work in weapon component performance; system performance, including radiation effects, reentry, penetration/laydown, flight, transportation, and storage; materials aging, including corrosion solder fatigue, polymer embrittlement, stress voiding, and adhesion ceramic failure; system response to credible events; and manufacturing, including encapsulation, brazing, forging/forming, welding, and soldering.

Sandia and Goodyear have studied and improved constitutive modeling that has been implemented to simulate aging in weapon geometries and optimize design of solder interconnects using model-based-design methodologies. In addition, the multilevel-material model approach pursued by Sandia and Goodyear has enabled calculations involving incompressible materials, resulting in the following improvements in the manufacture of encapsulated components:

- simulations now fall within the spread of test data from validation experiments;
- residual stresses are reduced by a factor of two from the original cure schedule; and
- a new cure schedule is half as long as the original cure schedule.



The partnership continues to grow, with Sandia and Goodyear now actively working in the following areas; computational mechanics, structural dynamics, information surety, microsensors, manufacturing reliability, and chemical separations.

In a recent Cooperative Research and Development Agreement (CRADA), Sandia and Goodyear collaborated on a project that applies reliability methodologies and capabilities to manufacturing processes, including total asset effectiveness encompassing the total life cycle of all equipment components and optimized equipment availability, production effectiveness, and quality. Reliability is a crucial part of Sandia's nuclear weapons program and the opportunity to apply Sandia's reliability methodologies to other applications, such as those of the Goodyear Tire and Rubber Company, helps to validate these methodologies and make them more robust for Sandia's high-reliability applications. Working with Goodyear allows Sandia to apply reliability analysis and optimization tools from the initial design through manufacturing phases; an exceptional opportunity to advance the state of the art.

Another cooperative project addressed passive sensing, which allows low-cost miniature sensors without their own source of power to be queried at a distance. Besides Goodyear's automotive applications, the technology is a platform that can be used to detect a variety of substances and conditions, making it a technology of interest to DOE/NNSA. The project provides Sandia an opportunity to apply and demonstrate the technologies over a wide range of environments and production constraints.

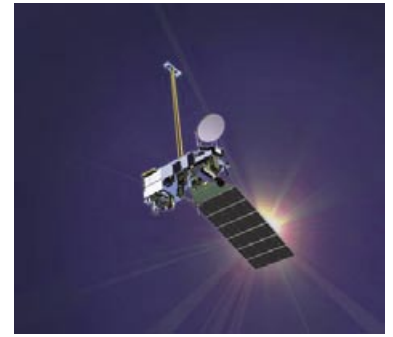
Goodyear's experience in manufacturing and complex manufacturing systems provides great opportunities for the continuous improvement of Sandia's capabilities for application to weapons. DOE/NNSA will continue to benefit from Goodyear's real-world experience and operations to further improve the scientific understanding of failure mechanisms and failure prediction.

Northrop Grumman Corporation

For a number of years, Sandia National Laboratories and Northrop Grumman Electronic Systems Division (NGESD) have collaborated to design, model, simulate, develop, prototype, and evaluate new micromachined inertial sensors and systems for use in military and aerospace applications. Sandia brings to the partnership its well-developed expertise in fabricating microelectromechanical systems (MEMS) using several processing methods. Under a current CRADA, the focus was on the bulk silicon micromachining process and DOE/NNSA's programmatic interest in guidance/control of weapon systems.

NGESD is a leader in the design and manufacture of navigation and tactical-grade inertial navigation systems for use in military and aerospace applications. Based on NGESD's assessment, future systems will need to be very small, much lower cost, and more rugged than existing systems. Micromachining was recognized for its ability to deliver products that can meet the reliability and size requirements of next-generation inertial navigation systems.

Sandia's defense programs encompass a wide range of experiments and monitoring that require the level of precise location information that can be delivered by inertial navigation systems. The most definitive need is in Joint Test Assemblies (JTAs) to provide information on weapon position, as well as very sensitive measurements of weapon system motion while in flight. Sandia also is involved in DOE/NNSA and/or DoD system tests for weapons, defense, and radar. In all of these applications, a very small, rugged, low-power, highly reliable, and low-cost Inertial Measurement Unit (IMU) will provide the foundation for Sandia's ability to achieve the desired system capability. Sandia's



Northrop Grumman Electronic Systems Division is a leader in the design and manufacture of navigation and tactical-grade inertial navigation systems for use in military and aerospace applications.

internal program has leveraged the work with NGECD to support and enhance the laboratories' ongoing efforts to develop an IMU that provides improved performance and reliability.

The work with NGECD greatly increases the laboratories' expertise in the dynamic modeling and simulation of very small mechanical systems made from silicon. These capabilities directly benefit Sandia's work in the Nuclear Weapons and Military Technologies & Applications Strategic Management Units. This work also advances Sandia's precision fabrication capability to assure that it will continue as a leader in the MEMS area.

The relationship between Sandia and Northrop Grumman, in addition to supporting DOE and DoD, also provides systems engineering and technology development efforts for NASA's Nuclear Systems Initiative and Jupiter Icy Moon Orbiter projects. Sandia has a continuing role in small special-purpose fission technology for civil space, commercial space, and special-purpose reactors for defense purposes. The CRADA with Northrop Grumman on behalf of NASA is directly supportive of the skill base that enhances all of Sandia's national security missions.

Lockheed Martin Corporation

The Ground Autonomy Platform Enabler (GAPE) CRADA effort focused the expertise of Lockheed Martin (LM) and Sandia National Laboratories on an investigation of key technologies and strategies for autonomous land navigation. The team considered perception of obstacles, vehicle localization, path planning, and system requirements during the 21-month effort. New algorithms to classify objects as detected by vision and ranging sensors were developed that can be used for path planning. Techniques for locating the vehicle using data from on-board sensing without the aid of GPS were developed. State-of-the-art video

compression was applied to narrow-band radio transmission and demonstrated on unmanned ground vehicle (UGV) platforms. The government's requirements and operational tactics for unmanned systems were deconstructed into lower-level requirements for hardware and software entities.

The collaborative project resulted in a design for a custom LAsER Detection And Ranging (LADAR) sensor which, when built, should achieve unsurpassed performance for UGV applications. Sandia has already integrated some of these technologies into existing projects and will continue to apply it in the areas of Emerging Threats and Nonproliferation and Material Control.

One possible future application might be that of a "robo-scout" autonomous vehicle that could be used singly or in swarms for reconnaissance missions in high-risk locations such as heavily fortified or mined areas where human scouts or special forces would be at risk. A potential use is mapping highly radioactive contaminated areas such as DOE nuclear waste sites, settling tanks, or during decommissioning of DOE nuclear reactors where human health physics technicians would be at risk of significant exposure to ionizing radiation.

In an emergency response mission, these technologies will enable or enhance the ability of response teams to remotely (more safely) and rapidly search areas for radioactive and special nuclear materials, insert precision instrumentation for device diagnosis, field communication gear to assure rapid transmission of the data to experts, and to enable precise, remote, direct action on a device. Likewise, it will enable safer, rapid recovery of samples in a post-detonation situation to determine the nature and origins of the device. This technology base will also enhance unattended autonomous systems able to gather surveillance data in remote areas. By enhancing an inspector's ability



State-of-the-art video compression was applied to narrow-band radio transmission and demonstrated on unmanned ground vehicle (UGV) platforms.

to reposition sensors to collect critical monitoring data, this technology can support treaty verification through the use of remote control of surveillance robots from half-a-world away.

Long-term Value

The long-term relationships among Sandia and its corporate partners bring about many technologies and products that support the security of our nation

as well as the health and growth of the companies. Sandia values the opportunity to bring stimulating challenges into the Labs from its commercial collaborators and the nation benefits both through direct security applications and the economic strength of U.S. companies.

IN BRIEF

Sandia and Ultramet Collaborate on NASA STTR

Sandia and Ultramet are collaborating on a CRADA to produce a thermally optimized fuel matrix for space reactor applications as part of a NASA Small Business Technology Transfer Research (STTR) project. NASA awarded Ultramet with a Phase II STTR. In the Phase II project, Sandia and Ultramet will further optimize the thermal properties of a uranium-containing tricarbide fuel matrix and design a bimodal power reactor that makes use of the many advantages of the gas-cooled foam fuel matrix. It is expected that the Phase II project will be fully successful. Ultramet plans to pursue a follow-on Phase III project for fabrication and testing of a fissile fuel assembly.

CRADA to Investigate Chemical Reactor Performance Gains

Sandia and Catalytic Distillation Technologies (CDTECH) signed a CRADA to develop a new generation of multiphase, multifunctional reactors for the chemical industry. Multiphase, multifunctional reactors offer the chemical industry the possibility of significant improvements in energy efficiency and performance through process intensification. Realization of these gains requires a systematic scale-up

approach for developing industrial-scale multiphase, multifunctional reactors from bench-scale and pilot-scale information. Commercial unit design has been hindered by problems with extrapolating small-scale results to commercial-scale units. Currently, the benefits of enhanced energy and process efficiency do not outweigh the potential capital risks involved with the commercialization of such reactors. This collaboration seeks to remove this barrier to commercialization.

The partners will investigate scale-up issues for these reactors. Models will be developed to predict their performance. This project has short-term horizons for commercialization and directly addresses priorities outlined in *Technology Vision 2020: The Chemical Industry* and the associated roadmaps. In addition, this CRADA will produce information that can be more generally applied to multiphase, multifunctional reactors.

Umbrella CRADA with FM Global

Sandia has signed an Umbrella CRADA with commercial and industrial property insurer FM Global, a risk management organization that is a leader in property loss prevention research and engineering. FM Global and the Fire Science and Technology Department at Sandia share the objective of predicting the flame heat transfer to solid objects

FM Global and the Fire Science and Technology Department at Sandia share the objective of predicting the flame heat transfer to solid objects immersed in the flames of large fires.



Lockheed Martin customers are pleased with the technical work accomplished and Sandia's attention to project cost and schedule.

immersed in the flames of large fires. There is a mutual need for scientific measurements of flame heat transfer in large fires for model development and validation. The initial project for this CRADA focuses on the characterization of heat flux distributions in pool fires.

LMC Shared Vision Program Review

Sandia hosted more than 30 Lockheed Martin visitors during the CY04 Shared Vision Program Review and related technical exchange meetings held in June 2004.

At the Program Review, CY2004 projects were discussed and several CY2003 project leaders reviewed their projects prior to final close-out. Lockheed Martin customers are pleased with the technical work accomplished and Sandia's attention to project cost and schedule. More than in previous years, Lockheed Martin Corporation and Sandia technical staff and managers used this June Program Review as a forum to discuss and prepare CY2005 Shared Vision proposals as well as efforts to pursue additional sources of funding, such as DARPA and the Office of Naval Research.

The proposal call for CY2005 projects for the \$8M Shared Vision Program was announced in July 2004. Sandians were encouraged to discuss potential projects with their Lockheed Martin counterparts.


Sandia Science & Technology Park Tenant Wins DoD Small Business Grant

A Sandia Science & Technology Park tenant, Team Specialty Products Corporation (TSP), and Sandia were awarded a six-month Phase I Small Business Technology Transfer Research (STTR) contract from the DoD Missile Defense Agency (MDA) for Radiation Hardened Silicon Carbide Devices and Circuits. Under the agreement, TSP will perform 70 percent of the work, with a Funds-In Agreement to Sandia for the remaining

30 percent of the effort. This is the first time that TSP and Sandia have teamed on an STTR contract. The partners hope to compete for the follow-on Phase II effort that would probably begin sometime in June 2005 and would extend to January 2007.

Sandia and Rockwell Collins Continue Pursuit of Joint Opportunities

Rockwell Collins and Sandia, through a Memorandum of Understanding signed in 2003, are pursuing opportunities for increased cooperation in research and development, manufacturing, and business development. Rockwell Collins is currently utilizing technology developed by Sandia to demonstrate new solutions that will address important national security issues. Pace VanDevender, Vice President of Sandia's Science, Technology, & Partnerships division says, "We are pleased with the progress of this relationship to date and look forward to successful technology transfers with a great potential benefit to the nation." Rockwell Collins Senior Vice President of Corporate Development, Barry Abzug comments, "This partnership is allowing us to focus our complementary capabilities on solutions that will enhance our nation's global security."



ADVANCING TECHNOLOGY THROUGH PARTNERSHIPS

Oil and Gas Technology Partnership Supports Energy Independence

Concerns about U.S. dependence on foreign oil are nothing new. Unsettled conditions in the Middle East, America's prime outside supplier of petroleum, have existed for decades. U.S. administrations have responded to the threat to the foreign supply pipeline by attempting to steady the political climate in the oil-rich nations. They prime the domestic pump with efforts to open up hitherto protected regions for development and with funding support for fossil energy R&D. The latter is an area where the government's legislative, administrative, and financial clout could bring America closer to energy independence without incurring the resistance of foreign powers or the outrage of U.S. citizens who believe that drilling rigs don't belong in wildlife refuges. One government-sponsored program, the Department of Energy's Natural Gas and Oil Technology Partnership, promotes technology transfer from the national laboratories to the oil and gas producers. The collaborative R&D projects in this program could slow the rate of increasing dependence on foreign oil by applying expertise in modeling and simulation, materials, sensors, and systems engineering to help increase the efficiency of extraction processes for oil and gas from domestic reserves.

DOE Program Links Labs, Oil & Gas Producers

In 1988, DOE established the Natural Gas and Oil Technology Partnership (NGOTP) to bring together the expertise of the national labs in collaborative projects with the nation's oil and gas producers and service companies. Universities and other research institutions are also members of project teams. The industry-driven program established review panels and forums that define

industry needs, provide annual project reviews, and determine the priority of new proposals and ongoing projects. Currently, in addition to the 9 national labs, the Partnership includes 9 major oil and gas companies, 10 independent producers, 45 service companies, and 12 universities. With the goals of producing more oil and gas from domestic reservoirs while safeguarding the environment and working within today's economic constraints, the NGOTP is currently fielding around 40 projects that explore the range of technological innovation throughout the research-development-application curve in a number of areas, including oil and gas recovery; well drilling, completion, and simulation; and environmental protection.

Sandia Models Well Processes

Among the many projects in which Sandia National Laboratories participates, one calls on Sandia's expertise in scientific computing and geomechanics to help the oil and gas industry develop new technologies for managing the interactions between fluids and solids near the wellbore, the below-ground column through which the drilling tools pass and the oil or gas is brought to the surface. The Direct Simulation of Near-Wellbore Mechanics project joins Sandia with the Massachusetts Institute of Technology, the University of Wisconsin at Madison, BP, ChevronTexaco, ConocoPhillips, Halliburton, Schlumberger, and Shell to develop computational capabilities that can be used by the industry to understand processes in the near-wellbore region. These processes commonly must cope with sand in the well fluid, which erodes casings, pipes, or pumps, or even plugs the well. Procedures, such as hydraulic fracturing (the pumping of fluid under high pressure into the reservoir rock to



Photo Courtesy of Kerr-McGee

The collaborative R&D projects in this program could slow the rate of increasing dependence on foreign oil by applying expertise in modeling and simulation, materials, sensors, and systems engineering to help increase the efficiency of extraction processes for oil and gas from domestic reserves.

create openings and increase the flow of oil or gas), or proppant transport, where particles are deliberately mixed with the fracturing fluid to hold fractures open after a hydraulic fracturing treatment, also create extremely difficult environments in which to operate.

Until recently, the understanding of these processes and the ability to predict the behavior of the materials near the wellbore has relied on computer modeling approaches that generalize the interactions between fluids and solids or on difficult-to-perform and expensive experimental studies. In this project, Sandia and its partners have developed 2-D and 3-D coupled (fluid and solid) computer models for the high-fidelity simulation of near-wellbore mechanics. These models illustrate the interaction of individual solid particles (and cemented particle assemblies) with other solid particles and with the surrounding oil or water.

With guidance from the project's industry partners, the model is now being applied at Sandia to simulate sand production from an idealized wellbore region to better understand the fundamental parameters, like the shape of sand grains and the stress-state of formations, that govern sanding and stabilizing mechanisms in the field. According to Sandia project leader Ben Cook, "These results can ultimately be used by industry to better predict the likelihood of sand production and to engineer new mitigating controls, economically necessary advancements for many potential oil-producing fields that are considered marginal prospects today because of sand-related problems."

Deepwater Drilling in the Gulf of Mexico

Sandia is also applying its capabilities in computational geomechanics to facilitate the oil and gas industry's push into the deepwater Gulf of Mexico,

regarded by many as the U.S.'s last great fossil energy exploration and production frontier. In the Well Integrity Assurance for Sub-Salt and Near-Salt Deepwater Gulf of Mexico Reservoirs project, co-funded by DOE and the industry partners, Sandia is teaming with BHP Billiton, BP America, ChevronTexaco, ConocoPhillips, ExxonMobil, Kerr-McGee, Petrobras S. A., and Shell to investigate the influence that overlying and adjacent undersea salt structures have on the development and production of deepwater Gulf of Mexico reservoirs.

The Gulf of Mexico is the most active fossil fuel-producing deepwater region in the world and is estimated to contain undiscovered recoverable resources of nearly 30 billion barrels of oil. By next year, as much as 67 percent of the daily oil production and 26 percent of the daily gas production in the Gulf of Mexico will come from deepwater fields. Complicating the recovery of these resources are huge formations of salt, thousands of feet thick, that underlie much of the deepwater. The complex salt tectonics, coupled with extremely deep water (up to 10,000 feet) and a reservoir up to 20,000 feet below the sea floor, require high development costs and innovative technologies to bring these fields on stream.

The cost of drilling these deepwater wells ranges from \$25–\$50 million per well, and drilling failures adjacent to salt formations have resulted in well abandonment costs of tens of millions of dollars. Wells may collapse during drilling because of the changing stresses of salt deformation. Even after a well is cased and completed, the slow movement of salt over the field lifetime may cause premature failure of the casing through shearing and twisting. Bernard Loony, BP America's drilling team leader for the Gulf of Mexico/Thunder Horse well team, says Sandia's work led to \$30 million in savings in well construction



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costs at the Thunder Horse field. “By working with [Sandia] on salt mobility, we have identified ways of positively impacting the project economics and delivering a more reliable solution. To me, this epitomizes the manner in which government agencies and industry can collaborate to produce extraordinary results.”

This project is using Sandia’s nonlinear finite element geomechanical computer modeling to investigate the stresses associated with salt formations and the forces that subsurface salt formations exert on well casings, with the goal of developing technologies to counter the effects of salt deformation. Complementing the computer modeling, laboratory-based rock mechanics experiments have been conducted to understand the behavior of Gulf of Mexico salts. Reservoir-scale computer models help researchers understand and predict the complex geomechanics of drilling and production through or next to salt formations and to identify optimal well trajectories and locations of potential borehole instability.

According to Joanne Fredrich, Sandia’s Principal Investigator, the project “targets an area of strategic importance to the industry, and is an excellent example of where our capabilities are exactly those needed to address key technical issues associated with developing these deepwater fields that are so critical to the nation’s energy security. Besides the ongoing work under this project, we are also actively working geomechanics-related issues for various partners.”

Solving the Sucker Rod Problems

Another Sandia effort for the NGOTP is Measuring Sucker Rod Pump Parameters Downhole, a project with Harbison-Fisher and the University of Texas at Austin. Sucker rods are steel rods that make up the mechanical assembly between the surface and

downhole components of a rod pumping system. Sucker rods are 25–30 feet long and are threaded at each end to enable the downhole components to be inserted and retrieved easily. Although sucker rod pumps are installed in nearly 90 percent of all oil wells in the U. S. and have been widely used for decades, many issues regarding their use are not well understood. Persistent problems in sucker rod pumping, which are difficult to diagnose from the surface, lead to reduced production and increased equipment failure.

This project developed an instrumented downhole pump to directly measure conditions inside the pump while it is stroking under wellbore conditions. A full-scale transparent pump, constructed and installed at the University of Texas at Austin, was instrumented with pressure gauges to measure the pressure profile throughout the pump while it is stroking. The transparent pump and fluids allow visual measurements and observations to be made to confirm the instrument readings. Tests were conducted of the pressures and loads in the pump under a variety of fluid and pumping conditions. Based on the experience gained in instrumenting the laboratory pump, as well as previous experience with the downhole tools, the instrumented pump was modified for use in an actual wellbore at reservoir temperatures and pressures.

The deployment phase of the project is currently on-hold due to a funding pull-back. If the project continues, the pump will be deployed in several wells and tested under a variety of pumping conditions. ARCO and other oil field operators will make the wells available and provide field test support. The data resulting from the tests will be widely distributed to the industry.

Ample Supplies, But Hard to Reach

Chip Mansure, Sandia’s project lead for the sucker rod investigation, believes that the NGOTP program is making a

Although sucker rod pumps are installed in nearly 90 percent of all oil wells in the U. S. and have been widely used for decades, many issues regarding their use are not well understood.

contribution to energy conservation. “For each reservoir tapped, the benefit in oil and gas produced should be maximized and the environmental impact minimized. For example, for the stripper wells, wells that make less than 10 barrels per day, which include the vast majority of old U.S. oil wells, most of the environmental impact was already paid up front when the wells were drilled. What remains to be done is maximizing the ultimate recovery while minimizing the incremental environmental impact.”

While oil and gas are not in any practical sense renewable resources,

according to the NGOTP approximately two-thirds of the oil-in-place in the continental United States remains in the ground – more than 300 billion barrels – and natural gas offers a secure, abundant, clean energy source. Advanced technologies are needed to economically produce more oil and gas from these domestic reservoirs while protecting the environment. Sandia, its national lab colleagues, and the oil and gas industry are aggressively pursuing the technologies that will ensure an energy-independent future.

Instead of working independently, as the previous company did, H2scan immediately entered into a CRADA with Sandia to develop its single-chip hydrogen sensor.

H2scan Applies On-going Collaboration for Success

Using a sensor technology licensed from Sandia and collaborating with Sandia through a formal Cooperative Research and Development Agreement (CRADA), H2scan LLC, has developed a small *in situ* sensor with the capability of detecting hydrogen down to 10 parts per million (ppm) and up to 100 percent. Today, H2scan has three retail products in commercial use. With its unique design, in-line process capability, and low-price-point per unit, H2scan has delivered sensors to over 200 government and industry customers. However, the commercial success of this technology was not always a sure thing. While H2scan recognized the value of having an on-going collaboration with the national laboratory that invented the technology, the first licensee to this Sandia technology tried to go it alone.

Sandia’s sensor technology was initially licensed to a different company. In 1996, researchers from that company learned about a new Sandia sensor technology. Using a field-effect transistor/resistor combination on the same die, the company promised to deliver a sensor with the capability of detecting hydrogen from 10 ppm to 100 percent hydrogen.

At the time, nothing like it existed in the market.

Recognizing the commercial potential of such a device, the company secured a license from Sandia for the sensor technology and started product development. After four years of work and an investment of about \$7 million, the company failed to produce a product that satisfied a need in the market.

In 2002, the company sold off its hydrogen sensor assets to H2scan LLC, a company started by Dennis Reid, a specialist in hydrogen-related applications and a former consultant to them. Reid, along with investment partners Chrysalix and Ravinia Capital, formed H2scan, and in just a little over a year, and with an investment of just over \$1 million, H2scan had developed its first retail product – a hand-held hydrogen leak detector with the capability of detecting hydrogen down to 10 ppm and up to 100 percent. H2scan’s sensors are user-friendly, fast, extremely sensitive, and can operate in a wide range of extreme conditions.

What made the difference for H2scan? How did this company develop its successful product in such record

time? If you ask Dennis Reid, he'll give you a simple answer: Sandia National Laboratories.

Instead of working independently, as the previous company did, H2scan immediately entered into a CRADA with Sandia to develop its single-chip hydrogen sensor. The R&D team at H2scan had almost daily interactions with the technology's inventor at Sandia. Together, scientists from H2scan and Sandia explored the next generation of this technology, and by January 2004 H2scan had its first successful portable hydrogen detector on the market. H2scan is scheduled to release a new area and process monitor in the first and second quarters of 2005, with all products using their latest generation sensor.

Dennis Reid advises other R&D companies who license a technology from the national labs to establish a close relationship with the technology's

inventor via a working partnership, such as a CRADA. Through a CRADA, the technology's inventor can provide the licensee with a wealth of invaluable information about the technology, including why it was invented and what it will take to achieve commercialization. The commercial CRADA partner can also take advantage of the laboratory's extensive knowledge base and state-of-the-art testing and facilities to open the door to successful product development and commercialization.

It is a mission of the Department of Energy and its national laboratories to turn government-developed technologies into opportunities for collaboration and commercialization. Companies who, like H2scan, take advantage of the many partnership mechanisms that are available at the labs improve their odds of reaping solid successes.

IN BRIEF

Shared Vision Project Delivers Innovative Packaging for MEMS Manufacturing

Working under the Shared Vision program, Sandia and Lockheed Martin researchers have developed packaging/integration techniques for MEMS applications for future space systems, including MEMS gyros and accelerometers for discovery missions, micro mirrors, health monitoring for launch vehicles, and other MEMS applications for science missions. This recently completed project considered the critical importance of switches (DC, RF, and optical) for many applications and undertook to provide support for three other projects driven by different business units. In the course of exploring optical elements integration into microsystem boards, the researchers conceived a technique for optical fiber switching that differs from techniques in the technical literature and demonstrated the capability for switching optical signals for both

multimode and single mode fibers. This project benefited the Defense Programs R&D goals through the establishment of new capabilities for integrating MEMS technology into microsystem boards.

Prognostics and Health Management Technologies for Joint Strike Fighter

Sandia and Lockheed Martin researchers have completed the Shared Vision project that developed and demonstrated Prognostics and Health Management (PHM) technologies (i.e., algorithms, sensor options, etc.) for aircraft support systems, such as the accessory drive gearbox (ADG) found on the F-16 and other military aircraft. PHM technologies will be used to predict degradation and failures in advance of when they occur in order to maximize the useful life of a system. The initial application and demonstration of the PHM technology was on the F-16 ADG, with a larger goal of applying the



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The CRADA testing concurrently demonstrated Sandia's new Diagnostics-While-Drilling (DWD) system for acquiring, transmitting, and displaying real-time downhole drilling data that was directly applied to control of the drilling process and avoidance of trouble.

technology to other aircraft systems, such as the Joint Strike Fighter (JSF) aircraft, which is heavily dependent on PHM for its Autonomic Logistics concept. PHM is critical to the ability of aircraft support systems to dynamically adjust and respond to events and trends as they occur.

This project supported the DOE/DP Directed Stockpile Program through the development of prognostics and health monitoring technologies. The area of predictive reliability is very important for both aging equipment and new equipment under strict requirements to significantly reduce Operations & Support costs. Prediction of degradation and failure will reduce maintenance costs and increase aircraft availability.

Sandia, Partners Conclude Drilling Study

Sandia, ReedHycalog/Grant Prideco, Security DBS/Halliburton, Smith Bits – GeoDiamond, and Technology International, Inc. have completed a series of hard-rock performance tests on advanced drag bits during drilling operations in the well-characterized lithology that underlies the GTI Catoosa Test Facility near Tulsa, OK. The FY2004 effort constituted the third and final phase of work under the CRADA that was established to promote the development and demonstration of “best effort” drag bits that can achieve high penetration rates and extended life in formations whose compressive strength (i.e., hardness) is comparable to values encountered during geothermal production drilling.

The CRADA testing concurrently demonstrated Sandia's new Diagnostics-While-Drilling (DWD) system for acquiring, transmitting, and displaying real-time downhole drilling data that was directly applied to control of the drilling process and avoidance of trouble. Engineering teams from all four participating bit manufacturers routinely relied on the

DWD outputs to prompt test interventions involving adjustments in operating parameters. Episodes of excessive downhole vibration or whirl were mitigated in a timely fashion by pulling off bottom and/or changing the drilling conditions. Complete sets of recorded DWD data were provided to the CRADA partners for their respective bits to allow post-test analyses that support future design improvements. The successes of the present test program strongly motivated follow-up demonstrations of state-of-the-art drag bits during production drilling at geothermal sites and/or deep, hot oil and gas fields. These demonstrations would benefit from the simultaneous deployment of the latest available version of the DWD system, which is evolving toward high-temperature capabilities for the downhole measurement tool and the utilization of wired drillpipe to eliminate the difficulties inherent in a long wireline connection between the tool and the surface.

Sandia and OptiComp Conclude Low-Power VCSEL CRADA

Sandia and OptiComp Corporation concluded a CRADA to develop low-power, selectively oxidized vertical cavity surface emitting laser (VCSEL) arrays. Arrays of 32 x 32 elements were optimized for flip-chip integration to silicon microelectronic circuits. Flip-chip (bottom-emitting) VCSELs operating near 1300 nm were also developed. Smart pixel optical microsystems are envisioned for numerous advanced applications in data communication, parallel optical signal processing, and optical computing. Cornerstones of this technology are low-power optical sources, such as vertical cavity lasers. Moreover, 2-D VCSEL arrays will enable large-scale optical integration of optics with microelectronics. VCSEL technologies have been under development at Sandia

for the past decade to address advanced defense applications. Beginning with a Phase II Defense Advanced Research Projects Agency (DARPA) Small Business Innovation Research (SBIR) grant, the program at OptiComp has evolved to the development of optical microsystems for Massively Parallel Optical Interconnect (MPOI) applications for microsatellite chip-to-chip interconnects for the Missile Defense Agency (MDA) and the Air Force Research Laboratory (AFRL), as well as avionic applications with the Naval Air Systems Command (NAVAIR). Benefits of the

CRADA included strengthening of the epitaxial materials growth and processing capabilities at Sandia and an enhancement of OptiComp's core competencies in optical microsystems through access to advanced materials and processes.



Smart pixel optical microsystems are envisioned for numerous advanced applications in data communication, parallel optical signal processing, and optical computing.

BRINGING SANDIA TECHNOLOGY TO MARKET



The Pentagon, imaged with synthetic aperture radar (SAR)

As a result of Sandia's sustained program of research and development on SAR, several state-of-the-art systems have been provided to various DoD operational units, either from Sandia directly or through a corporate partner.

Trekking Through the Valley of Death: From Discovery to Market with Some Help from Our Friends.

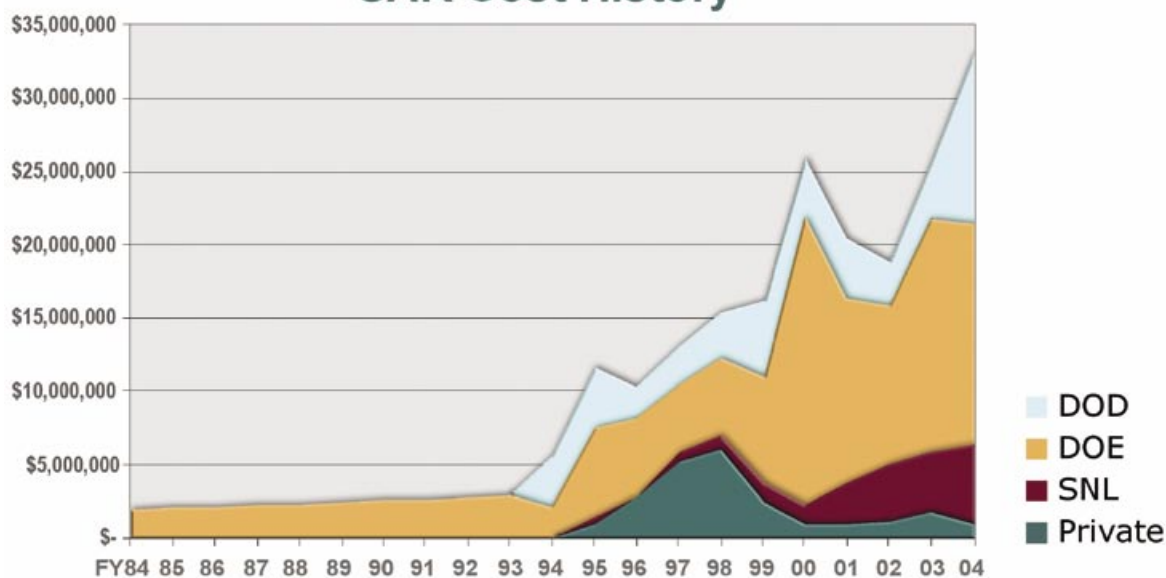
If you think of the proof-of-principle of a new technology as one mountain peak and the successful commercialization of that technology as another peak, then the space representing the period of time between those two peaks can be seen as a valley. This period in the transition from discovery to market is littered with the good ideas that never made the climb up and out of the valley. In technology commercialization parlance, this graveyard of inventions is known as the Valley of Death. Like all scientific organizations with a mission to transfer technologies to the public sector, Sandia has left its share of R&D creations in the Valley. But like the other really good research institutions, Sandia also has a number of technologies that have made it through the Valley and to the marketplace.

The path of one of Sandia's successes, synthetic aperture radar (SAR), began over twenty years ago with funding from the Department of Energy's Defense Programs (DOE/DP). Government funding from DOE (both DP and Nonproliferation), a number of

Department of Defense (DoD) agencies, including the U.S. Navy and the Defense Threat Reduction Agency, and Sandia's internally administered, DOE-funded Laboratory Directed Research and Development (LDRD) program has continued throughout the past two decades. In the early 1990s, private industry began providing additional support for the development of a commercial product. It was not until the mid-1990s, though, that the technology matured to a level that offered sufficient benefits to defense industry corporations to encourage them to make substantial investments at Sandia in this ground-breaking, all-weather imaging system. The chart below shows the funding source history at Sandia for SAR.

As a result of Sandia's sustained program of research and development on SAR, several state-of-the-art systems have been provided to various DoD operational units, either from Sandia directly or through a corporate partner. These systems, which have earned recognition for their exceptional performance and utility, are deployed in various critical and time-urgent national security missions, including direct support of Joint Forge in Bosnia, Enduring Freedom in Iraq, and homeland defense activities.

SAR Cost History



The latest SAR development to survive the Valley of Death and which is poised to attain commercial status is the miniSAR. At about 25 pounds, the miniSAR is one-fourth the weight and one-tenth the volume of its predecessors currently flying on larger unmanned aerial vehicles (UAV), such as General Atomics' Predator. The new miniSAR has similar capabilities as its larger cousins, including the ability to take high-resolution (four-inch) images through weather, at night, and in dust storms. The only difference will be range. The larger SAR can produce an image in the 35 kilometer range due to its larger antenna and higher transmitter power, compared to the miniSAR, which has a range of about 15 kilometers, which is more than adequate for small UAV military reconnaissance applications.

Future versions of miniSAR are planned that will shrink the total weight to less than 10 pounds by leveraging both in-development and yet-to-be developed Sandia microsystems technologies. "There are several technologies that may help reduce size and weight to enhance mini-SAR," says Charles Sullivan, who manages Sandia's Radio Frequency (RF) Microsystems Technology department. One is an RF switching device, using MEMS, that can create phase shifts or time delays along an array of antennas. These phase shifters have the affect of "tilting" the phase, which alters the direction of the array's beam, Sullivan explains. "We have more freedom to put the antenna where we want and reduce the size of the overall system."

Also being studied are solid-state power amplifiers built with materials such as gallium nitride (GaN). The goal of these devices is to realize high output microwave power at high efficiency to replace the vacuum tubes and modules currently used. This should also reduce the size of the radar. MEMS technology

approaches, such as micro-channel heat-pipes, are being looked at to help manage the heat spread from these solid-state devices. As RF MEMS and GaN technologies become available, they will be integrated into even smaller versions of Sandia SARs.

Funding and collaborative support for these enhancements will come from both government agencies and private industry. Perhaps not every good idea to come from Sandia's SAR research programs will survive the trek through the Valley of Death, but Sandia and its partners have shown that for SAR and many other technologies they know the way from Discovery to Market.

Downstream Successes: Sandia Technologies in the Marketplace

Sandia technologies that have made the trek from the laboratory through the Valley of Death and into the marketplace can be considered downstream successes. Two of these successes are highlighted here and two are featured in the Protecting Our Homeland section.

- Jess, software licensed by Sandia to local, state, and federal government agencies, academic laboratories, classrooms, and public and private commercial entities from small start-ups to Fortune 50 companies, is a tool for building computer-based expert systems.
- A range of partnership mechanisms, including a Small Business Technical Assistance, followed by a Work for Others agreement, a User Facility agreement, and finally an Entrepreneurial Separation to Transfer Technology (ESTT) for a member of Sandia's technical staff, helped Aerospace Composite Structures, LLC become a market-driven production company.

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Imaginative Software Licensing Program

Jess, the Rule Engine for the Java Platform, is a tool for building a type of intelligent software called an Expert System. An Expert System is a set of rules that can be repeatedly applied to a collection of facts about the world. In traditional computer programming, the programmer tells the computer precisely what to do, one step at a time, and the computer then solves the problem that is implicit in this description. Jess is a declarative programming environment that lets the programmer describe the problem explicitly; Jess then decides what steps to follow to reach a solution. This makes Jess an excellent tool for solving difficult or ill-defined problems. Jess is portable to a wide range of computer systems. Users of Jess can build Java software that has the capacity to “reason,” using knowledge the user supplies in the form of declarative rules. Jess is small, light, and one of the fastest rule engines available.

Jess has been licensed for use by local, state, and federal government agencies, academic laboratories, classrooms, and public and private commercial entities from small start-ups to Fortune 50 companies. Jess's problem-solving abilities have been applied to an extremely varied range of problems in the technology, insurance, and financial services industries, and in academic artificial intelligence research. The source code is available to licensees, making Jess an attractive choice where security, mission-criticality, or customization are paramount.

Jess was written by Ernest Friedman-Hill at Sandia National Laboratories as part of an internal research project. The first version of Jess was written in late 1995. Jess has evolved considerably since then, to the current 7.0 release code-named Charlemagne. This release includes a major update to the rule engine

itself as well as a new graphical rule development environment based on the open-source Eclipse IDE (integrated development environment).

The technology transfer model for dissemination of Jess Software was designed by Craig Smith at Sandia. Craig recognized that Sandia, as a federal laboratory with outstanding software development tools and personnel, was an excellent environment to launch a comprehensive software licensing program that could potentially reach a worldwide user group. Collaborating with Dr. Friedman-Hill beginning in 2001, Craig created a series of licensing models designed to satisfy all end-users with varying needs and requirements, while achieving rapid deployment and accessibility of the Jess source code. The standardized, but tailor-made, license models now serve as the foundation of this technology transfer effort, offering ease of availability and efficient and consistent support of the software. Response times to all licensing, technology transfer, and technical inquiries (averaging 25-40 per day) are typically less than one business day.

Commercial licenses were further refined into internal use (enhancement of internal operating systems) and external use (embedded into a commercial product for distribution and sale). Additional licenses were added to the portfolio to allow 1) for a six-month evaluation of the software, for demonstration and development, to contractors and corporations doing work exclusively for U.S. government agencies, 2) for state and nonprofit institutions, foreign companies and governments, and 3) for extended use of binary versions of the code. In response to individuals wanting to use Jess for personal, noncommercial use, a low-cost home-office license edition was created and quickly gained popularity among individuals wanting to use Jess as a learning tool.

The teaming efforts of Ernest Friedman-Hill in technical development and Craig Smith in business development combined to capture and, in fact, leverage this critical response time element. A company wanting to integrate Jess into their operating systems or applications has the opportunity to do so within days, perhaps even the same day, due to Sandia's responsive, efficient, and streamlined licensing process. The same company requiring implementation support, specialized technical support, or development inquiries receives an equally rapid response. And this is not the exception, it is the absolute rule. All licensees, approaching 1,500 and growing every day, receive this rapid response. This is a critical aspect in the transfer of this technology, as the efficient and responsive reputation for Jess is a major attraction for new licensees. The Jess technical development and business models currently in place have the capacity to accommodate increasing numbers of licensees with the same rapid-response time support and service.

The beneficiaries of this technology transfer effort are the clients, customers, and end-users of the services and products provided by the Jess licensees. Licensed users of Jess include local, state, and federal government agencies, academic institutions, small-to-large commercial entities, individual users, and information technology research organizations. Some of the government agency beneficiaries include: all branches of the U.S. military, Central Intelligence Agency, Federal Bureau of Investigation, Department of Labor, Department of State, Department of Commerce, Department of Energy, Federal Emergency Management Agency, Internal Revenue Service, National Aeronautics and Space Administration (NASA), and the European Space Agency (ESA). Industry sectors include software, hardware, electronics and computer technology manufacturers, insurance, financial

services, brokerage and mortgage services, telecommunications, healthcare, retail, aviation, aerospace, heavy manufacturing, and nearly all aspects of the e-commerce industries.

Benefits to the consumers include a more robust, faster, and more powerful and versatile problem-solving capability to meet ever-increasing performance requirements. The result is a rule engine with vastly improved and more accurate response for conditional branching or decision-making requirements.

As of September, 2004, Sandia has issued in excess of 1,500 licenses granting rights to use Jess source code. More than 1,450 of these licenses were issued to business entities with multiple users, anywhere from 5 to 500 individual users. These users in turn may develop, design, and implement operating systems, products, and applications that benefit tens or even hundreds of thousands of end users. Licensed users of Jess are entitled to keep rights to derivatives; however, improvements to the code are typically offered back to the Jess Users group under Users Contributions on the Jess website.

In addition, the downloadable binary trial versions of Jess available on the Jess website and the educational binary version available through the publication "Jess in Action," (Manning Press, Greenwich, CT 2003) have offered educational benefits to thousands of students, programmers, and software developers in both the private and public sectors.

As a national laboratory, Sandia often has interactions with local, state, and federal government agencies, academic institutions, and commercial businesses in the information technology sector. However, the technology transfer success of Jess has allowed Sandia to offer, under license but at no monetary cost, a highly acclaimed and superior rule engine for use by the U.S. Air Force, U.S. Army, U.S. Navy, and U.S. Coast Guard, special

Licensed users of Jess include local, state, and federal government agencies, academic institutions, small-to-large commercial entities, individual users, and information technology research organizations.

An improved multifaceted model for Jess training is currently under development with a small specialized technical solutions firm that will result in Sandia's ability to offer customized and tailored training modules for every specific requirement of the Jess licensee.

work within the Department of Homeland Security and the Department of State, applications in space projects conducted by NASA and the ESA, and literally thousands of research projects within universities and academic institutions in the U.S. and around the world.

Improvements in commercializing this technology are also continuous and ongoing. A business model to port Jess to Microsoft's .NET platform is in progress. This effort will result in a partnership agreement with a small new-venture firm and will target development of advanced declarative systems within the financial services, telecommunications, healthcare, and e-commerce industries. An improved multifaceted model for Jess training is currently under development with a small specialized technical solutions firm that will result in Sandia's ability to offer customized and tailored training modules for every specific requirement of the Jess licensee.

This technology transfer effort has resulted in a continually improved commercial software application that fills a critical need in information technology development. Jess has been applied in numerous areas and its impact has been far-reaching. There are more than 1,500 Jess licensees in total with a minimum of 25 licenses pending at any given time. This has resulted in licensing revenue in excess of \$1,618,000 to date.

While generating licensing revenue is not the primary motivating factor in the transfer of this technology, Sandia has clearly benefited from this revenue stream as the majority of funds are returned to the technical program to be used for present and future research and development. Jess is a subset of Sandia's Advanced Software R & D program that includes development of Open Source and DOE-applicable R&D of projects like SIMBA, xdamp, Invisible Router, Ddace and OPT++. The royalties that are returned to the technical line go to support mission-critical software development.

Dozens of new start-up companies have integrated Jess into their initial product offering. Currently, two venture start-up companies, InferenceWeb and Morris Technical Solutions, are basing their growth on Jess-related development.

Creating a successful licensing program for this technology has provided initiative for continued development of Jess. This continued development has spawned innovative new features, functions, and programs within the Jess rule engine, leading to new research in related but separate information technology arenas. This in turn has generated vibrant interest and high expectations from external customers for a superior product, which Sandia continues to develop using R&D funds generated from the revenue of Jess licenses

Long-term Relationship with Aerospace Composite Structures, LLC

A long-standing, multi-agreement relationship between Sandia National Laboratories and a Rio Rancho, New Mexico company, Aerospace Composite Structures, LLC (ACS), has helped develop a product line that is revolutionizing air freight containers.

In 1999, ACS began its relationship with Sandia with a Small Business Technical Assistance, followed by a Work for Others agreement, a User Facility agreement, and finally an Entrepreneurial Separation to Transfer Technology (ESTT) for a member of Sandia's technical staff, Matt Donnelly. The early technical assistance addressed the design of a gantry robot-based manufacturing process, structural analysis of container components, and testing of materials used in the container panels. In August 2004, Donnelly became the Vice President for Production for ACS. This range of partnership mechanisms helped ACS accomplish a complete transition from an R & D company to a market-driven production company.

The early research conducted among the company and Sandia largely revolved around the commercial application of U.S. weapons technology, advanced aircraft development, and the Strategic Defense Initiative National Defense Project. Efforts to apply advanced material technology to commercial usage resulted in the identification of a composite whose characteristics of reduced weight and extraordinary durability made it uniquely suited for use in the production of air transportable freight and baggage containers.

ACS then pursued the objective of developing materials, designs, and processes for commercial application. After over four years of research, ACS has developed a new generation air cargo container utilizing composite materials. This new container offers increased strength, excellent impact resistance, easy repair, and reduced heat conductivity when compared to aluminum.

ACS manufactures the AeroBox, a thermoplastic air freight and baggage container. According to the company, the containers are more dent-resistant than aluminum containers. They can also be easily repaired by airport personnel with special patches rather than being

transported to a repair station. Repairing a traditional aluminum container can have a turnaround time of between twenty hours and one week. The thermoplastic composite material and the design approach allows a simple procedure for disassembling containers for flat-load shipping and storage that will significantly reduce operating costs for the carriers.

ACS units have been certified by the Federal Aviation Administration (FAA) and the European Joint Aviation Authority (JAA). The company has delivered over 100 containers to Aer Lingus and is currently delivering over 250 units to Virgin Atlantic Airways. The Rio Rancho plant, which now employs 33 people, is expected to grow to 100 employees, in addition to the sales staff at John F. Kennedy Airport and sales agents in Asia and Europe.

In March 2003 ACS became a wholly owned subsidiary of AeroBox, PLC, a UK based holding company whose shares are traded on the London Stock Exchange. Over 15 airlines based in the United States, South America, Europe, Africa, the Middle East, and Asia have been testing over 100 units since the first deliveries in September 2003.

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IN BRIEF

Sandia's RIFF Technologies More Useful Than the USAF 9.5 Ton "MOAB" bomb?

Yes, at least according to MSNBC. In an article on the Rapid Identification of Friend or Foe (Instant Shooter ID) technologies licensed from Sandia to Law Enforcement Technologies of Colorado Springs, the news network states: "Army units struggling with snipers and ambushes in Iraq, and Marines poised to land in war-torn Liberia now carry with them a powerful weapon never before used on the battlefield: tiny field test kits known as "RIFFs" that enable a soldier to determine quickly whether

someone has fired a gun in the previous 24 to 48 hours. While the RIFFs may not generate the "shock and awe" of other new weapons — the Air Force's 9.5-ton "MOAB" bomb, for instance — officers involved in planning both missions say the shooter ID kits may be a lot more useful."

Microsystems Center Broadens its Relationship with SUMMIT™ Partner, Fairchild Semiconductor

Sandia is helping enable Fairchild's strategy of providing an expanded turnkey Microelectromechanical Systems



MEMS devices are extremely small machines, usually sensors or actuators.

(MEMS) service to customers wishing to gain access to SUMMiT V™ (Sandia Ultra planar Multilevel MEMS Technology). Sandia and Fairchild amended their license agreement to convey nonexclusive rights to Sandia's SUMMiT V and IMEMS intellectual property, and to add rights to Sandia's SUMMiT trademarks. Fairchild expects to be a foundry for advanced MEMS devices for the Labs' national security system integrators. MEMS devices are extremely small machines, usually sensors or actuators. Manufacturing these devices is challenging and the patented SUMMiT V process enables higher-performing products due to tight control over film stress and device topography. Under terms of the license, Sandia's Microsystems Center will evaluate test structures and MEMS devices for compliance with the SUMMiT process. Also, Fairchild recently received a grant from Maine's Manufacturing Extension Program to further enable its surface micromachining capabilities. Initial funding under the grant will be used to provide parametric wafer testing, which will increase confidence in process reliability.

Additional Licensees for Decon Formula

Sandia is soliciting additional licensee(s) interested in licensing decontamination formulation technologies primarily to develop products for industrial and commercial uses, including general disinfection and/or sterilization operations, mold remediation, and consumer disinfection products. Three companies, which were down-selected from those who responded to the October 13, 2003 Federal Business Opportunities Announcement, have received an invitation to give presentations at Sandia. Other efforts are underway to solicit specifically targeted companies of interest.

General Atomics Advancing Sandia's SAR Technology

Sandia's Synthetic Aperture Radar (SAR) technology will be applied by General Atomics to a lighter, more reliable, easier-to-maintain version of the Lynx radar system for the U.S. Army. Lynx uses SAR to provide all-weather reconnaissance capabilities, including tracking ground-moving targets such as vehicles. According to General Atomics, the Lynx II version will deliver photographic-like images with 4-inch resolution at up to 19 miles away, depending on weather conditions. Lynx has been flown on manned and unmanned aircraft, including Predator, Predator B, and the Army's I-Gnat-ER. General Atomics has a 24-month contract with the Army that includes development, demonstration, and delivery of six systems.

Sandia Seeking Partners for Liquid Sensing Project

In March 2004, in a solicitation in Federal Business Opportunities conducted as part of Sandia's Mission Centric Venturing Project, Sandia announced that it was seeking companies interested in partnering opportunities for development of a prototype for a fiber-optic sensor to detect the interface between a clear and an opaque liquid. Since water generally accompanies the production of crude oil, and the two liquids must be separated before the oil is to be processed into useful fuel sources, the sensor's successful development has important implications for the oil industry. In the longer term, Sandia is interested in partnering with companies for future applications of this technology via licensing or cooperative research and development agreements.

Salt River Project CRADA Coming to a Successful Conclusion

Sandia and the Salt River Project (SRP) Agricultural Improvement and Power District have entered into the final

phases of a CRADA developing a solar thermal water heating system based on a new technology known as Roof Integrated THERmosiphon (RITH). SRP has licensed the new RITH solar technology to a manufacturer who is preparing to make the system commercially available. The manufacturer plans to market the system to residential home builders in the southwest U.S and has already received some interest. Since January 1998, when Sandia and SRP first started collaborating, several technical achievements have produced a cost-effective solar water heating system that can compete directly with conventional gas and electric water heating systems.

Sandia Licenses RAMPART™ to CAP Index

Sandia and CAP Index, a leader in the field of loss, risk, and crime forecasting, prevention, and analysis, have signed a partially exclusive license for the commercialization of RAMPART™. RAMPART™ is a screening-level program used to determine the risk to a building by natural hazards, crime, or terrorism. Sandia developed the software to help the General Services Administration (GSA) assess the risk of threatening events to the nearly 8,000 federal buildings GSA manages nationwide. CAP Index plans to customize the software and market it for use in the financial, healthcare, real estate management, and retail industries.

Sandia, LLNL Participating in Open InfiniBand Alliance

Sandia and Lawrence Livermore National Laboratory (LLNL) are members of the Open InfiniBand Alliance, a consortium that also includes Dell, IBM, Intel, Sun Microsystems, and a number of other firms. InfiniBand has been available since 2000 as a high-bandwidth, low-latency alternative to the Ethernet and other specialty solutions for connecting clusters. It has a potential transmission speed of 30 gigabits per second and can simultaneously handle multiple channels. The alliance will develop an open-source software stack for high-end technical computing applications and commercial database software. The work supported by the consortium will not be tied to any particular vendor's platform. According to Matt Leininger, a computational scientist at Sandia-California, "Those proprietary software stacks, which don't allow users to easily mix and match products such as computer and storage systems, are an impediment to the growth of InfiniBand." Sandia and LLNL have signed the promoter's agreement for Open InfiniBand and are in the process of helping draft bylaws and determine the structure of the alliance.

The alliance will develop an open-source software stack for high-end technical computing applications and commercial database software.

PROTECTING OUR HOMELAND

Downstream Successes: Sandia Technologies in the Marketplace

Two Sandia technologies that made the trek through the valley of death (see Bringing Sandia Technology to Market) are providing protection to our homeland.

- The SMART system, licensed to Thermo Electron Corporation, utilizes radiation detectors and custom hardware and software to identify radioactive materials.
- The Explosives Detection Personnel Portal, a walk-through system for rapid screening for trace amounts of explosives, was selected as a winner of the Federal Laboratory Consortium's 2005 Excellence in Technology Transfer Awards. The portal uses a Sandia-patented air-flow design and air sampling technique, licensed to Smiths Detection, to capture trace explosives.

SMART System for Radiation Detection

The SMART system detects radioactive materials passing within a few meters of the detector. It automatically identifies the radioactive isotope(s), including mixed sources, in real time and indicates the level of confidence (low, fair, high) that the material has been identified correctly, with particular attention paid to identification of special nuclear material (SNM). When the detector senses material of interest, a video imager captures the image of the person or vehicle carrying the radioactive material. The SMART system, which was funded by DOE, consists of commercial hardware (gamma-ray and neutron detectors) combined with customized electronics and software developed at Sandia. FitToDB is copyrighted software for isotope identification and PASSBY

is copyrighted software for command, control, and communication of isotope identification data.

The SMART systems will be a key component in the protection of military assets and the homeland. The systems, when fully commercialized and proven, can be deployed in environments that could be targets for terrorist nuclear attacks, for example, military bases, high-profile civilian sites, and transportation hubs.

License agreements with Thermo Electron Corporation's Radiation Measurement & Protection business unit have been in place since May 2003 for the FitToDB and PASSBY software. Thermo Electron is incorporating the Sandia software into existing Thermo Electron hardware platforms.

PASSBY Version 1.0 is used to continuously monitor spectra from a low resolution (NaI) spectrometer and an optional neutron counter. The false alarm rate is very low, leading to increased specificity in terms of identifying true positives in terms of radioisotopes. The PASSBY program is used in conjunction with the FitToDB algorithm to fully analyze the collected data.

FitToDB automatically determines which isotopes are present when a radiation measurement is made by analyzing the gamma-ray spectra collected with a low-resolution gamma-ray spectrometer. Gamma Detector Response and Analysis Software (GADRAS) is used to compute templates for a variety of shielding configurations for each of the possible isotopes present. The combined software yields increased sensitivity and specificity for detecting and monitoring discrete radioisotopes under a variety of shielding configurations.

The licensee, Thermo Electron, is conducting market research and assessing possible applications at U.S. ports and is also building eight units for use by the Defense Threat Reduction Agency (DTRA). DTRA has deployed

The systems, when fully commercialized and proven, can be deployed in environments that could be targets for terrorist nuclear attacks, for example, military bases, high-profile civilian sites, and transportation hubs.



the systems at military bases, and has contracted with Sandia to supply additional units. DTRA has also used Sandia facilities to conduct side-by-side tests of various radiation detection systems from industry and Sandia.

The Homeland Security Advanced Research Projects Agency (HSARPA) has included SMART in a Broad Agency Announcement for Detection Systems for Radiological and Nuclear Countermeasure.

U.S. Customs has been operating a radiological/nuclear testbed of the SMART system at selected U.S. ports. Performance has been very reliable, and state and federal representatives have been impressed. A potential future outcome of the technology transfer effort is that Thermo Electron has the chance to bid on an upcoming procurement contract for a large number of spectroscopic portals for the Department of Customs and Border Protection.

Thermo Electron plans to combine Sandia algorithms with their existing algorithms to create a value-added platform, based on the proprietary Thermo Electron architecture. The ThermoX-Channel architecture, combined with Sandia intellectual property, will yield the ultimate system for detecting and unambiguously identifying radionuclides in motion. This revolutionary new approach to detecting and identifying isotopes will also, in the future, allow several detectors (rad/nuc, chem, bio, etc.) to be supported off a single-board architecture, yielding simplicity and total integration of multi-analyte detectors. The ultimate goal is to scan/monitor 10,000 containers/day/location at a vehicular speed of 3 mph.

Key customer-value drivers that Thermo Electron has identified, which the X-Channel architecture combined with licensed Sandia IP will address, include: an integrated sensor network; fixed and mobile sensor monitoring; centralized monitoring capacity; integrated data formatting and reporting;

and real-time threat detection capability. Applications include secondary inspection at borders and ports to include shipping containers, rail, pedestrian, and trucks; integration into mobile van/truck based systems; and primary spectroscopic inspection at borders and ports.

Thermo Electron has invested significantly in market research, identified several port/border locations, tested/demonstrated setup locations, and taken opportunities to team with three other major DOE labs to validate performance in the field (at port/border/airport locations, police departments, first responders), in order to ultimately generate customers, sales, and use. A number of these activities are tied to NA-25, Department of Homeland Security Second Line of Defense missions. In addition to these projects, Thermo Electron plans to team with three different major systems integrators in their ongoing product development and deployment efforts.

Ultimately, this success story in the radioisotope detection/identification field will lead to future interaction/collaboration/technology transfer efforts of mutual interest to Sandia and Thermo Electron in the homeland security area, for example chemical/biological detection and monitoring.

Screening for Explosives on Personnel

For the difficult problem of detecting trace explosives on personnel, Sandia used a systems approach to integrate sample collection and preconcentration, detection, and operator notification. The resulting Explosives Detection Personnel Portal is a walk-through system for rapidly screening personnel for trace amounts of explosives. The portal uses a Sandia-patented air-flow design and air sampling technique to capture trace explosives. The system has demonstrated a 90 percent efficiency in collecting explosives particles.

A potential future outcome of the technology transfer effort is that Thermo Electron has the chance to bid on an upcoming procurement contract for a large number of spectroscopic portals for the Department of Customs and Border Protection.



While the FAA (and now the Transportation Security Administration) saw the need for an explosives detection personnel portal in airports and funded the development of the prototype, the agency also saw the need for quick technology transfer to enable mass production on a commercial scale.

The portal looks like an oversized airport metal detector with vents and nozzles on its inside walls and ceiling. People are directed to walk into the portal and then wait for a few seconds as the portal passes a series of puffs of air over them to dislodge particles and vapor from their hair, clothes, skin, and shoes. The portal's blower draws in 300 liters of air per second, which entrains the particles before they settle on the portal floor. Explosives' molecules tend to be "sticky," which helps them adhere to the dense metal screen used in the first- and second-stage preconcentrators. Heating the metal screen "boils off" the explosives into a gas phase, which is then delivered to the Smiths Detection IONSCAN™ detector after two stages of preconcentration. Sandia's preconcentration technology solved the problem of the "mismatching inlet flows"—commercial detectors have relatively small inlet flows compared to the volume of air that must be generated to obtain a head-to-toe sample from a person.

A chemical sensor called an ion mobility spectrometer recognizes the chemical signatures of a variety of explosives. If a person has even a minute amount of explosive residue on his or her skin or clothing, an alarm displays on an adjacent computer screen. The SENTINEL walk-through portal can screen approximately 420 people per hour.

To help understand the large volumes of air and minute quantities of explosives detected in this process, Sandia project leader Kevin Linker says, "Imagine that you have the equivalent of 1 milligram of aspirin dissolved in an Olympic-sized swimming pool that holds one million gallons of water. That's 30 parts of aspirin per a quadrillion parts of water [a quadrillion is 10^{15}]. Not only can we find the explosive equivalent amount of

that shaving of an aspirin, we can tell you the color of that aspirin."

The Explosives Detection Personnel Portal was designed to prevent terrorist acts and to save lives. Unlike bulk explosives detection technology, which looks for the actual bomb, trace detection looks for bomb indicators—traces of contamination on the person who has handled the explosives. Whether the terrorist has packed explosives in his or her checked baggage, or is hiding explosives underneath clothing, the trace explosives detection process can single that person out. While the FAA (and now the Transportation Security Administration) saw the need for an explosives detection personnel portal in airports and funded the development of the prototype, the agency also saw the need for quick technology transfer to enable mass production on a commercial scale. The technology transfer recipient was originally Barringer Instruments, Inc., a company that specialized in security tools, especially explosives detection, via its desktop detector, the IONSCAN™. Commercialization began under Barringer's lead and continued after Barringer's acquisition by Smiths Detection.

The original personnel portal research was funded by the FAA and the Department of Energy Office of Safeguards and Security.

IN BRIEF

Sandia Hosts Annual Homeland Security/Combating Terrorism Conference

Sandia National Laboratories, the University of New Mexico, the U.S. Department of Justice, and a number of national, state, county, and local educational and public safety organizations hosted the annual Homeland Security/Combating Terrorism Conference in Albuquerque. The five-day event in October 2004, drew more than 650 public safety personnel from 150 agencies, including Michael D. Brown, Under Secretary of Emergency Preparedness and Response for the U.S. Department of Homeland Security. Media interest included correspondents from the Associated Press, the Washington Post, and about a dozen representatives of local media outlets.

Conference participants could choose from many presentations related to preventing, mitigating, or remediating terrorist activities, including Current Global and National Perspectives on Terrorism; Domestic Terrorist Groups in the United States; Developing and Sharing Terrorist Intelligence; Threats, Targets, and Cyber Security; and Bio-Surveillance.

RAM-C™ License for the Isleta Pueblo Police Department

The Isleta Pueblo (New Mexico) Police Department signed a Noncommercial End User License for Sandia's Risk Assessment Methodology for Communities (RAM-C), a step-by-step security assessment process. Personnel from Sandia's Security Systems Analysis department trained two police officers from the Pueblo, along with members of other law enforcement agencies, at the Albuquerque Police Academy. The Pueblo is the first tribal police department in New Mexico to request training in this methodology. According to the Pueblo's Chief of Police, Ruben Davalos, his department utilized the training within ninety days of receiving it.

The Pueblo is the first tribal police department in New Mexico to request training in this methodology.

SUPPORTING REGIONAL AND SMALL BUSINESS

Technical challenges have ranged from helping a company make better spark plugs to helping automate the New Mexico chile industry.

Small Business Technical Assistance, New Mexico Style

Completing its fourth year, Sandia's New Mexico Small Business Technical Assistance initiative supported New Mexico small businesses with over 1,200 separate technical assistance projects through a tax credit arrangement approved by the state legislature. Technical challenges have ranged from helping a company make better spark plugs to helping automate the New Mexico chile industry.

Researchers from the Labs assisted New Mexico small businesses throughout the state. During 2004, Sandia earned \$1,799,922 in tax credits that could be used to assist New Mexico companies. Two-thirds of these companies were small businesses in rural New Mexico and the rest were small businesses in Bernalillo County. Sandia's program coordinator, Mariann Johnston (Office of Advocacy and Small Business Development), explains, "Assistance helps small businesses move forward through issues and helps get products or services into the market. It's also an opportunity for technical staff to work with small businesses outside their normal projects and to make a difference for New Mexico. In some cases, it is technically challenging."

Chama Railroad Rescue

In response to a request from New Mexico officials, Sandia researchers Ted Borek (Materials Characterization department) and Don Susan (Materials Reliability department) traveled to the northern New Mexico village of Chama, to help the narrow-gauge Cumbres & Toltec Railroad. With only two out of ten steam

locomotives running, the railroad needed to move forward with repairs. "The railroad isn't permitted to weld on trains unless the welders know the composition of the metals," explained Borek. Lacking a way to determine the composition of several key locomotive components, they turned to Sandia for help. Borek returned from Chama with drill borings from several key parts and slivers of metal chiseled from a massive locomotive driving rod.

"This was a routine analysis for us, but they were thrilled we could help them out and provide a quick turnaround," Borek said. "The metallurgy was required to determine a safe and suitable welding procedure for the main driving rod on the locomotive," explained Kim Smith Flowers, Chama resident and general manager of the company operating the railroad. "We had to make that determination before we could approach repairing the rod in a way that would be acceptable to the Federal Railroad Administration." Don Susan returned to Chama with Borek a week after the samples were collected to test the materials for hardness. Information on the metals was submitted as a part of a package to the railroad administration to get needed welding permits and keep the repairs on schedule.

High-Tech Chile

New Mexico's Chile Task Force, a partnership of growers, producers, and research institutions founded six years ago, is always looking for improvements in New Mexico's chile production and competitiveness. They called upon Sandia's advanced sensing capabilities. Sandia worked with Task Force members to incorporate advanced image processing into mechanical cleaning for chile producers. "The industry is moving from manual harvesting and cleaning toward more automated systems," explains Sandia's Chris Wilson (Intelligent Systems Sensors and Controls depart-



Photo by Lew Hartwick ©2004

ment). “We looked at the mechanical devices under development and decided we could help most with a measuring system.” The system measures chile on a conveyor belt after mechanical cleaning, quantifying percentages of chiles, and “trash,” which consists of sticks, leaves, and other natural debris.

The measuring system analyzes the chile and debris on a conveyor belt based on color differences. A digital camera connected to a portable computer takes still images of the conveyor. Software analyzes the image and provides feedback to the operator on percentage of product and waste. The operator can then adjust the cleaner and again check the output plots to see the effect. Right now, most quality measurements are made by “eyeball,” Wilson explains. The new system was put to the test during the harvest in October, measuring results from a new cleaning machine developed by other members of the Task Force. Sandia is applying technologies it uses in its robotics labs, but “with a lot of variables” in terms of outdoor conditions instead of a controlled lab environment, Wilson said. “It builds on and adds to what we are doing. We are stretching ourselves in some different directions. I think it will make us stronger.”

SQUID Sensors Failure Rate Reduced

STAR Cryoelectronics develops, manufactures, and markets ultra-sensitive Superconducting Quantum Interference Device (SQUID) sensors and advanced PC-based SQUID control electronics products worldwide. The ultra-sensitive SQUID sensors available from STAR Cryoelectronics, a Santa Fe company, are based on low-temperature superconductor (LTS) and high-temperature superconductor (HTS) technologies. SQUID sensors have applications in biomedical imaging, nondestructive testing of materials, geophysical exploration, and basic research.

Sandia’s Joe Michael (Materials Characterization department) worked with STAR Cryoelectronics to provide detailed scanning electron microscopy and focused ion beam micromachining of the company’s low-temperature sensors, providing expert consultation on deposition processes. Sandia’s analysis and data helped determine reasons for device failure. With rapid turnaround and effective interaction between Sandia and the company, production processes could be immediately fine tuned to meet delivery deadlines.

Cross-section data enabled STAR to modify their process and eliminate defects that were causing their devices to fail, resulting in the inability to complete substantial commercial orders and two R&D contracts for NASA. Following the successful implementation of process improvements based on Sandia’s expert assistance, STAR has completed all of the contracted tasks. Without the revenues from these projects it is very likely that the business would have failed.

Matching Hot-Iron Brands with Ranches

Sandia researcher John Browning (Reliability and Human Factors department) helped a former New Mexico state livestock-brands supervisor develop software that instantly matches hot-iron brands with cattle owners and ranch locations. The software, expected to be commercially available in 2004, comes at a time when the government is seeking faster, more detailed information about livestock, particularly during disease outbreaks. Nickel Brand Software, a small, woman-owned business in Moriarty, New Mexico, offers a product that allows a user to find the owner of a brand by sketching the brand on the screen of a computer palm pad or by scanning the brand with a hand scanner. It allows states that use livestock brands to keep a system that has worked well for more than 100 years and “to bridge the



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gap between historical and current animal identification methods.”

John Browning helped enhance the software to apply a reliable single-pass, three-level artificial neural network to the problem of matching brands. Browning’s human factors suggestions helped eliminate human error to enhance the company’s existing software. The artificial network operates similarly to neurons in the brain, Browning explained. “You train it to establish certain connections, so that when it sees a certain input it will fire. The system eliminates obvious brands and arrives at a dozen or fewer choices for a human to consider, instead of looking through thousands of possibilities. Humans are very, very good at matching under these circumstances,” Browning said.

Nickel Brand is attempting to establish a dual confirmation system for animal tracking. The software will be compatible with tablet PCs and PDAs, which will provide ease-of-use in the field. Their methodology combines image recognition of brands with current RFID (radio frequency identification) tagging systems and links the two technologies together. Loretta A. Martinez, founder of Nickel Brand Software, said matching brands with ranches can be tricky. In New Mexico alone, there are about 28,900 brands representing thousands of working ranches, each of which may use several brands. New Mexico ranks sixth in the U.S. for number of brands, after Texas, Montana, Colorado, Nebraska, and Wyoming.

Salt Basin Water Resources Analyzed

Last Chance Water manages water resources in the Salt Basin (Otero County, New Mexico) and evaluates the water supply available to potential markets. Sandia provided assistance in predicting the long-term effects of pumping large volumes of water from the Salt Basin

by monitoring and testing water levels. Sandia researcher David Chace (Repository Performance department) interprets and models the test results. This led to a plan for the proper management of water resources for the benefit of the state of New Mexico.

Sandia’s Repository Performance department provides experimental and field studies capabilities to assist DOE’s Carlsbad Field Office (CBFO) in assuring uninterrupted licensure and permitting of the Waste Isolation Pilot Plant (WIPP). The department also offers scientific expertise to resolve geo-technical and related issues that non-DOE customers may face. Using these capabilities on the Last Chance Water project, Sandia was able to identify, quantify, and characterize a new and renewable water source within New Mexico.

Prior to this project Sandia had limited experience managing large-scale water resources, such as the Salt Basin. After a second successful year with the project, David Chace states, “it is now clear that Sandia is the leader in ground water resources.” Software platforms were dynamically enhanced for application on numerous other projects and a tool that can assist in evaluating long-term effects of water extraction on hydrological systems was also developed.

Five Megawatt Spark Plug

Enerpulse, an Albuquerque company, is a research and development company in pulse power, specializing in automotive ignition, specifically spark plugs. They are developing a new spark plug that has the potential to be 10,000 times more powerful than current spark plugs. It is expected that this new generation of spark plugs will be available on new cars in the next three to five years and a retrofit model for older cars will be available in 2005.

Sandia’s Ceramics and Glass Processing department has expertise in a broad range of processing options for many

types and compositions of prototype ceramic, glass, and glass-ceramic components. Capabilities range from chemical synthesis of powders and glasses, through powder processing and billet formation and machining, to complete component fabrication and testing. Sandia researchers Roger Moore and Mike Hutchinson applied these skills to the project, which allowed them to gain experience with atomizing and applying gold paste material to spark plug casings, a challenging issue that involved complex geometry. The result of their assistance was a spark plug that can produce 5 megawatts of peak power.

Sandia's assistance allowed Enerpulse to overcome a major hurdle in developing their most recent product. Several rounds of research and development were eliminated, the fabrication process was expedited, and the product cycle time was shortened by two years.

Programming a Robot – Securely

A two-company collaboration between Beer Engineering Inc. and Applied Thermal Systems, both of Albuquerque, with support from Sandia, resulted in a system robot being programmed more efficiently and securely. Beer Engineering, Inc. performs research and development in the areas of system engineering, complex robotics and automation systems, networks, and software development. Their customers include the U. S. Air Force, John Hopkins, Mayo Clinic, Johnson & Johnson, Sandia National Laboratories, University of New Mexico, and AT&T Bell Laboratories. Beer worked with Sandia's Cliff Loucks (Intelligent Systems and Robotics department) to choose the best robot for the project, a Fanuc R-2000, a robot nearly identical to a robot Loucks programs at Sandia.

Applied Thermal Systems designs and manufactures thermal equipment. With nine product lines, the company provides a wide-range of thermal products to meet customer needs. Equipment varies from tabletop systems to stand-alone robotic work cells. The systems, many of which are vacuum systems, can be integrated into Class 1 clean room environments with temperatures to 1200 °C. For this project, Applied Thermal Systems programmed the robot, which involved a direct integration of the robot with the system from the inside of the robot looking out, focusing on the perspective of how the peripheral and process equipment is assembled and integrated within the robot.

This project involved taking a very crude, labor-intensive process and developing a new secure and fully automated process. Sandia's assistance allowed both of these companies to gain more experience with the capabilities and limitations of today's commercially available robots. This "pick-and-place" robotic workcell project gave Loucks the opportunity to extend his skills in synergistic integration of mechanical engineering with electronics and intelligent computer control in the design and manufacture of products. The companies hired another employee and received considerable employee skills training from Loucks. Another variation of a software product was developed and gross revenues for the companies have climbed.



This project involved taking a very crude, labor-intensive process and developing a new secure and fully automated process.

*Jim Manatt, CEO
of Providence
Technologies, Inc.
talks about the growth
of his company and
credits the relationship
with Sandia for helping
with technology
development as well
as credibility.*

Small Business Partner Reports on Success



Relationship with Sandia Opens Doors for Small-town Oil & Gas Company

*By Jim Manatt, Chief Executive Officer,
Providence Technologies, Inc.*

Providence Technologies, Inc. [Roswell, New Mexico] is fortunate to have been a technology-development partner with Sandia through the New Mexico Small Business Assistance (NMSBA) program since its beginning. We are approaching commercialization now and expect to launch our new technology spin-off, Focus Energy Corporation, this year.

Providence and Focus are small, highly focused (hence the name) high-technology companies in the upstream oil and gas 3-D geophysical imaging business. Our vision is to see what has not been seen before in the subsurface, ahead of the competition, creating significant economic value for our customers, investors, and company. We concentrate on difficult imaging problems that bring to market otherwise bypassed opportunities in high-potential hydrocarbon regions.

Our companies deliver our niche-focused technology and solutions to our customers, the major and independent oil and gas producers in the U.S. and internationally. We have business relationships with some 3,500 earth-science professionals, managers, and officers in most of the world's energy companies, from the mega-majors, including British Petroleum, Exxon/Mobil, and ConocoPhillips, across the spectrum to the small, well-established independents such as SunValley Energy in Roswell. We work around the world from Texas to Yemen as 3-D seismic imaging specialists, contractors, and operators, helping develop new prospects for drilling, both in the wildcat and producing-field areas.

Late in 2001, as the NMSBA program was getting off the ground, Providence brought our technology needs and ideas to Dave Aldridge, Dave Borens, and Marianne Walck in Sandia's fossil energy/geophysical group. Following up on a successful technical assistance project almost four years ago, last year we added a funds-in Work For Others agreement with the Sandia's environmental sciences group, led by Sean McKenna, to collaborate on imaging technology development.

The relationships we have built with these teams are extremely rewarding and important to us for many good reasons. Foremost, as is necessary for program funding, Sandia's world-class expertise, talent, intellect, and skill is simply otherwise not remotely available to our company here in New Mexico. Even if it were, we would never be able to afford the cost. Secondly, when our customers start wondering who in the heck these Providence/Focus guys from Roswell are, the door to credibility opens wide when we explain our technology-development relationships with Sandia National Laboratories. So, in our business plan and future years' budgeting, we include additional funds-in

projects to continue this phenomenal relationship with these people who have become our friends and mentors, not to mention our resource for world-class technology solutions urgently needed in industry today.

The current project focuses on developing imaging applications not available today that will address a critical, strategic, and timely need. We are looking for bypassed oil and gas between producing wells in major U.S. fields. The potential volume is truly strategic. According to the University of Texas, in our target geology, we are looking at 5 billion barrels mobile of bypassed oil, which is five times the size of the U.S. Strategic Petroleum Reserve. It seems to us that this is a compelling justification for Sandia's involvement as one of the world's premier energy/engineering laboratories.

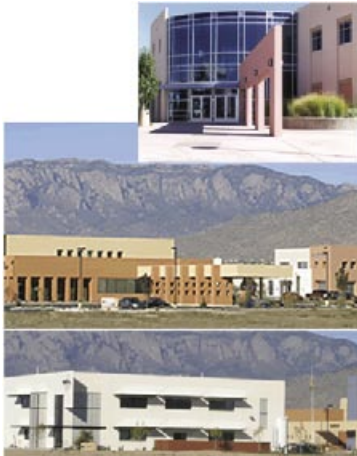
Our project is developing outside-the-box solutions to our industry's universal seismic bandwidth barrier, which limits our ability to resolve smaller but potentially lucrative targets beneath the surface. While there are some excellent technologies for this in the world's easier sandstone reservoirs, we work on the world's more complex, heterogeneous, randomly behaved carbonate reservoirs. And we do so with Sandia experts, renowned in our industry for their scientific, technical, and computational prowess.

Our business plan for Focus, which has been in the seed-stage, pre-operations phase, included nonconfidential portions of our ideas and white papers which suggested "we could or we might" be able to resolve the fine scale of our potentially lucrative objectives. Today, as a result of the work at Sandia, Focus Energy can show our customers and investors that we are resolving discrete objectives in an actual producing West Texas field, with direct extrapolation to New Mexico's fields. Moreover, beyond our backyard proving grounds, the methods we are developing have direct application potential to other important oil and gas reservoirs in the world, including the Arabian Platform.

Today, thanks to Sandia, Focus Energy has arrived at a significant milestone, the point of technical and field proof-of-concept on the basis of hard data, justifying start-up of a new \$6.5 million privately funded Roswell technology venture. The business plan includes expansion through hiring of 12 highly compensated scientists, engineers, and support personnel to execute the five-year technology implementation plan, creating new high-tech jobs in rural New Mexico. The successful outcome of this phase is expected to lead to a merger/acquisition of the venture by a major company during this period. In our heart of hearts, we work hard everyday and pray for the kind of success that will enable us to perhaps buy out our investors, at many times their initial investment, and to carry the company forward into the public domain, using as our model for the 21st Century the great success of our mentor, Robert O. Anderson, creator of the Roswell-born ARCO, whom we consider to be history's most successful independent wildcatter.

If you can't dream it, you can't do it. We can dream it and we can make it a reality with the phenomenal help of our colleagues and friends at Sandia National Laboratories and the vitally important NMSBA technology-development program.

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An Economic Impact Analysis performed this year found that the average salary for the Park was \$55,750 and determined that the Park created an additional 3,200 indirect jobs.

Sandia Science & Technology Park Continues to Serve New Mexico, the Nation, and Sandia

In August 2004, the Sandia Science & Technology Park (SS&TP) was the site of the Taiwan/New Mexico Workshop hosted by Senator Jeff Bingaman. The workshop focused on best practices in technology commercialization and research parks in Taiwan and New Mexico. At this workshop, representatives from Taiwan and New Mexico signed a Memorandum of Understanding, agreeing to develop a long-term collaborative relationship that promotes the interchange of best practices in technology park operations, advances in technology transfer, and business opportunities among science park tenants.

The Park, a 200+ acre technology community located adjacent to Sandia National Laboratories in Albuquerque, is a model for public/private partnerships. Tenants in the Park have access to Sandia's world-class technologies, state-of-the-art facilities, and internationally recognized scientists and engineers.

During FY2004, the SS&TP received a \$750,000 grant from the U. S. Department of Commerce's Economic Development Administration to be used for switching and network equipment for the Park's recently installed fiber optic network. The SS&TP also received \$240,000 in Capital Outlay funding from the New Mexico State Legislature. The funds will be used for signage and the construction of a 1.5 acre pocket park.

The SS&TP continues to foster economic development in New Mexico. In FY2004, five new tenants joined the Park:

- Ktech Corporation, a Sandia strategic partner that provides scientific and engineering support;
- Sunwest CAD, a software and training company that provides products and services to Sandia and other Park tenants;

- Sandia's Controller and Pension Plan Management Center, a Sandia support organization;
- Heel, a homeopathic pharmaceutical company; and
- the Optic Ring for Broadband Information Transport (ORBIT) Hub Building, which houses the switching and network equipment for the Park's fiber optic network.

The Park now serves as home to twenty organizations employing more than 1,000 people. An Economic Impact Analysis performed this year found that the average salary for the Park was \$55,750 and determined that the Park created an additional 3,200 indirect jobs. To date, public and private investment in the Park exceeds \$161 million.

Tenants in the Park have experienced many successes this year and have won several impressive awards. Applied Technology Associates won the Small Business Administration's "2004 Region VI Small Business Prime Contractor of the Year Award," and was later named the SBA's "National Prime Contractor of the Year." TSP received several awards, including the Space Alliance Technology Outreach Program (SATOP) award as the "Alliance Partner Providing the Most Global Resources" and the award for "Best Performing Platinum Alliance Partner Award." In addition, TSP was named a recipient of the Small Business Administration's (SBA) "2004 District Directors Choice Award" for their participation in community activities and sales and profit growth.

Dr. Larry Adcock, Assistant Manager for Science and Technology at the Department of Energy/National Nuclear Security Administration (DOE/NNSA) Sandia Site Office said of the Park, "Since the 1940s, the DOE pro-

grams have been an integral part of the economy of New Mexico. New Mexico state and local governments as well as private sector agencies have worked long and hard to foster links between DOE's National Laboratories and New Mexico businesses. As the Nation moves toward an ever-increasing technology-based economy, it is important that DOE and its New Mexico national laboratories increase the flow of scientific and technological advancements to the U.S. private sector. Additionally, to fulfill the federal missions of the national laboratories, they need to exploit the technical achievements of companies in New Mexico. The Sandia Science & Technology Park initiative is a truly collaborative public/private effort that serves both the needs of DOE and the economic well-being of New Mexico businesses and citizens."

The Park's established partners include Sandia National Laboratories, DOE/NNSA, the City of Albuquerque, Technology Ventures Corporation, and the three landowners: Albuquerque Public Schools, the New Mexico State Land Office, and a private entity called BUILD New Mexico/New Mexico Development Foundation. In addition, the Park maintains strategic partnerships with the New Mexico Congressional Delegation, Bernalillo County, the Mid-Region Council of Governments, the Public Service Company of New Mexico and the Economic Development Administration.

As the Nation moves toward an ever-increasing technology-based economy, it is important that DOE and its New Mexico national laboratories increase the flow of scientific and technological advancements to the U.S. private sector.

IN BRIEF

Small Business Programs Highlighted in DOC Economic Development Report

On November 20, 2003, the Department of Commerce Assistant Secretary for Technology Policy, Bruce Mehlman, released the report, "Partners on a Mission: Federal Laboratory Practices Contributing to Economic Development." The report addresses federal laboratory practices that are contributing to local economic development efforts. The report documents nine unique programs that go beyond immediate laboratory missions to provide communities with greater access to lab technologies and facilities. Sandia's Small Business programs represented Sandia as one of nine programs selected out of the entire federal laboratory system of 712 labs. The American Society of Mechanical Engineers focused attention on the report

at a Congressional Noontime Briefing on Capital Hill. Vic Chavez of Sandia was invited as one of three lab representatives to present the results of the study to members of Congress.

Sandia's Mentor Protégé Program - 2004 Second-Year Teams

Sandia is in its third year of the Mentor-Protégé Program that assists small businesses (protégés) in improving their business practices and processes to become more effective suppliers. The program features a second-year option for teams wanting more time to achieve their objectives. Seven of the eight 2002 first-year protégés opted to sign on for a second year. The Orientation/Kickoff for these teams was held January 29, 2004. During 2004, the teams met monthly to work on achieving their business devel-

Nine companies were presented with a 2003 Innovation Award, highlighting projects in which a true partnership between the small company and Sandia resulted in business and technological success for the company.

opment objectives and attended two summits to network and to learn more about subjects related to their growth.

NMSBA Celebrates Small Business Successes

The New Mexico Small Business Assistance (NMSBA) program completed its third year of providing technical assistance to New Mexico small businesses through a tax credit passed by the New Mexico Legislature. A celebration of the success of the program was held in May 2004 at the Albuquerque Museum. Small business representatives and Sandia principal investigators involved in the assistance projects attended the event. Nine companies were presented with a 2003 Innovation Award, highlighting projects in which a true partnership between the small company and Sandia resulted in business and technological success for the company.

Solar Start-Up Shines

Advent Solar won a \$7,000 cash prize and \$3,000 in business services in 2004 after taking first prize in the National Clean Energy competition in Austin, Texas. Advent Solar licensed intellectual property from Sandia and includes as a principal James Gee, a former Sandian now on entrepreneurial separation and client of Technology Ventures Corporation. The competition was part of the three-day National Renewable Energy Laboratory Industry Growth Forum, which is a springboard for new energy companies looking to attract investors. The award is meant to spotlight energy ideas and viable business plans. Advent

Solar hopes to manufacture a new kind of solar cell and has consistently attracted investor funding, including a \$400,000 investment in November 2003. The company intends to build a manufacturing facility at the Manufacturing Training and Technology Center in the Science and Technology Park at the University of New Mexico.

FOSTERING PARTNERSHIPS

Sandia Develops Technologies and Entrepreneurs for a Global Marketplace

By David Goldheim, Director Corporate Business Development and Partnerships

Sandia National Laboratories' leadership recognizes that technology transfer helps provide commercial products for our primary missions. Licenses and agreements with commercial firms help us leverage our capabilities. Partnerships create advocacy, which helps maintain existing programs and create new ones. And, technology partnerships generate revenue. My organization, the Corporate Business Development and Partnerships Center, is charged with developing and administering partnerships, which include contractual agreements and licenses, for the technical organizations. Given the goal of promoting mission success, a key to ensuring that success is keeping the skills of our scientists and engineers sharp by giving them opportunities to complete the most demanding technical investigations. One of the ways we do that is by building into our primary research and development concentration an application-based focus through collaborative and customer-directed technical work.

Matching Technologies and Partners

Companies come to Sandia looking for assistance in developing or enhancing technologies for their commercial applications. By matching companies with the technologies they seek, using our experts, tools and programs, we help bring the right technologies to market and hone the skills of our employees. Along the way, we also build constituencies, create a supplier base, and generate revenues.

Our professionals in business development, agreement development, and intellectual property protection, work together to identify potential collaborators and partners, from start-ups to large established firms, who may be interested and able to work with Sandia to mature and commercialize the technologies. We look for partners who are the most capable and enthusiastic about a given technology. The mix of technology, marketplace, and company gets distilled into which technologies are best commercialized by which partners.

We also work with the Department of Energy's National Nuclear Security Administration (DOE/NNSA) and other federal agency customers to determine where the technologies, when mature, will find a home. For example, if the Department of Defense (DoD) needs a chemical/biological sensor that can be developed from an existing Sandia technology, Sandia can work with a commercial partner to advance the technology so that the partner will be able to offer its sensor to DoD. Or, perhaps, a company would license a Sandia technology to incorporate into one of its products for use in a homeland security application. In both those scenarios, Sandia is supporting two aspects of its mission, to enhance national security and to advance U.S. economic competitiveness.



Given the goal of promoting mission success, a key to ensuring that success is keeping the skills of our scientists and engineers sharp by giving them opportunities to complete the most demanding technical investigations.

TPP funds encouraged external partners to collaborate to develop the technology through the prototype to the application phase.

Legislated Funding Decisions

We are encouraged by management and authorized by legislation to facilitate the transfer of technology (the National Technology Transfer Competitiveness Act and the Bayh-Dole Act), to ensure that appropriate government-developed technology is made available to the nation for the advantage of the taxpayers and to make U.S. industry more competitive. Sometimes, though, changes in policy and the funding that follows can have a detrimental effect on the commercialization process. A serious blow to the application phase of technology development in the last few years was the shutting down of DOE's Technology Partnerships Program (TPP). Removing this funding source, which required matching funding by the commercial partner, has inhibited relationship building with commercial organizations and technology maturation that the national labs used to support their own technology-development efforts. TPP funds encouraged external partners to collaborate to develop the technology through the prototype to the application phase. Another casualty of the elimination of TPP funding was the loss of a national small business assistance program.

For Sandia, that loss of support for small business development is somewhat offset by a State of New Mexico program: the New Mexico Small Business Assistance program (NMSBA). Legislation passed by the New Mexico State Legislature provides Sandia a credit against gross receipts taxes owed to the state by Sandia. That credit lets Sandia provide limited consulting support (up to \$10,000 for rural businesses and \$5,000 for urban businesses, per year) to in-state small businesses at no additional cost to the business. However, this offsetting solution for the loss of TPP funding is only available to small businesses in one state; the national benefit has been lost.

Innovative Technology and Expertise Transfer Programs

While the NMSBA and other programs, like Sandia's Mentor-Protégé program, regional economic development initiatives, and the Office of Small Business Advocacy, provide direct support to small businesses, the Sandia Science & Technology Park is a 240-acre technology community adjacent to Sandia that gives tenants, which include spin-offs and suppliers, access to our world-class facilities, including the Microelectronics Development Laboratory, the Robotic Manufacturing Science and Engineering Laboratory, and the Advanced Manufacturing Processes Laboratory. Since the ground-breaking ceremonies in 1998 for the first tenant, EMCORE Corporation, the park has grown to include 20 companies employing 1,046 people, over \$17 million in revenues from tenants to Sandia generated by cooperative agreements, licensing agreements, and in-kind services, over \$76 million in procurements from Sandia to Park companies, and over \$141 million in private investment.

Sometimes, the way to keep a skill is to give it away. This seeming contradiction is played out in our program that lets employees take Sandia's technologies into entrepreneurial environments. This method of commercializing our technologies assures that Sandia has an inside track for prototyped, engineered, and marketed products. Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program allows an eligible employee to leave the Laboratories to start a new business or expand an existing one based

on Sandia technologies, tempering the risk to the individual by promising employment reinstatement within two or three years if the entrepreneur chooses. When nascent entrepreneurs self-identify or are encouraged by their managers, Sandia's New Ventures program directs them through the ESTT process, including a suggestion that they work with Technology Ventures Corporation (TVC), an experienced business incubator, to develop the skills needed to prepare a compelling business plan, obtain external funding, hire and manage staff, and enter the private sector as effective competitors in the marketplace.

As well as providing opportunities for entrepreneurial-minded employees, Sandia also recognizes those inventors and authors who do not choose to develop or expand outside businesses by sharing a portion of the licensing and royalty fees earned on their innovations at the annual Royalty Awards ceremonies for the New Mexico and California sites. While a percentage of the income is distributed to inventors, authors, and contributors, the major portion is given to their home organizations for investment in future R&D. These organizations may also use the retained royalty income to support attendance at conferences and seminars and for publishing in technical journals, ways in which Sandia's technologies are broadcast throughout the academic, government, and commercial worlds.

Sandia's multi-faceted approach to transferring technology is successful when measured by the number of entrepreneurs and spin-off companies; number of patents and copyrights sought by the Laboratories; and number of and revenue from licenses and agreements with commercial firms and federal agencies.

One area that continues to challenge us is the ability to fund technologies through the Valley of Death, that period in a technology's development when R&D has not yet led to a prototype. Given the relative immaturity of most of the national laboratory technologies, dedicated funding from the Laboratories alone is usually insufficient to develop them through prototype and to application. Building relationships with commercial partners to leverage DOE/NNSA investments and enable the maturation, verification, and validation of promising technologies is a challenge we welcome at Sandia. Each business arrangement includes a unique set of circumstances requiring both traditional and innovative mechanisms to achieve success. Through these mechanisms, our partnerships programs continue to support our internal and external customers and to mature both U.S.-grown technologies and entrepreneurs to be successful in today's competitive, global marketplace.

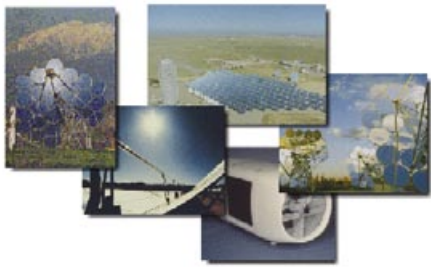
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IN BRIEF

Sandia Sponsors, Participates in Western Governors North American Energy Summit

The Western Governors Association (WGA) North American Energy Summit was held at the Hyatt Regency in Albuquerque in April 2004. The meeting brought together government leaders,

experts, and other interested parties from the U.S., Canada, and Mexico to initiate the dialogue on how to ensure a secure, abundant, affordable, and environmentally responsible energy future. As a panelist, Sandia President and Chief Executive Officer C. Paul Robinson discussed the Security of the



In the renewable energy section of the Expo, Sandia showcased concentrating solar power technologies and ongoing efforts with the Western Governors Association to facilitate 1,000MW of large-scale solar technologies in the southwest over the next few years.

North American Infrastructure. Sandia was also represented with four exhibits in the Energy Futures Expo.

Participants at the Summit included a number of governors from western states (including the Summit host, New Mexico Governor Bill Richardson), their Canadian and Mexican counterparts, New Mexico Senators Pete Domenici and Jeff Bingaman, and DOE Deputy Secretary Kyle McSlarrow and several Assistant Secretaries.

In the renewable energy section of the Expo, Sandia showcased concentrating solar power technologies and ongoing efforts with the Western Governors Association to facilitate 1,000MW of large-scale solar technologies in the southwest over the next few years. Sandia and the Navajo Tribal Utility Authority hosted a booth that focused on renewable energy applications in Indian country, where renewable, off-grid energy sources are a perfect fit.

In the Public Information and Decision-making Tools section of the Expo, Sandia highlighted the breadth of its work in energy surety, with emphasis on sustainability, security, reliability, and safety from a systems perspective. The exhibit complemented Paul Robinson's remarks, and included recommendations to the western governors on actions they can take to enhance energy surety.

Sandia and Lawrence Berkeley National Laboratory hosted an exhibit in the Advanced Technologies section that demonstrated the potential of solid state lighting to reduce electric loads in the future. It also highlighted the research the two labs are conducting to accelerate the introduction of light-emitting diode and organic light-emitting diode technology.

Margie Tatro, Director of Energy, Infrastructure, and Knowledge Systems, led Sandia's efforts for the Summit, and Ann Riley, as Sandia's liaison to the WGA for the Summit, helped coordinate Sandia's participation. Sandia was a sponsor of the event.

NASA and NSF Proposal Reviews

Clint Atwood, a Sandia business development specialist, participated as a peer reviewer on a NASA Special Focus Panel in November 2003. The panel reviewed and critiqued proposals related to NASA's Advanced Space Propulsion program in the category of metals and alloys. Clint also served as a proposal reviewer for the Design, Manufacture, and Industrial Innovation Division of the National Science Foundation (NSF). The panel reviewed and critiqued proposals related to Manufacturing Machines and Equipment.

New Mission for International Programs Working Group

The International Programs Working Group (IPWG) has been a lab-wide forum for networking and education for Sandians involved in international work. Having been relatively dormant for the past couple of years, the IPWG was re-initiated in September 2003 and began a strategic planning process that showed the need for the IPWG to rethink its mission. The results of the strategic planning – including the new mission – were presented at the January 2004 IPWG meeting. The new mission will include being more closely aligned with Sandia's strategic directions and providing more services to the lab, including providing ad hoc advice regarding individual agreements and international "savvy" for lab planning purposes at all levels.

Patent List Supports Technology Research Corridor

A list of licensable patents in 21 specific technology areas was presented to the Technology Research Corridor (TRC) for possible bundling of Sandia patents with patents from Los Alamos National Laboratory (LANL) and the University of New Mexico (UNM). TRC is made up of the major research institutions throughout the state, along with the New Mexico state government. Its goal is

“promotion of the commercialization of publicly funded science and technology to create in New Mexico a more diversified economy, new high-wage technology companies, and greater private-sector wealth.” The patent list was presented at the January 14, 2004 board meeting of the TRC. The specific technology areas were defined by using International Patent Code (IPC) designations and determining which IPC categories had significant numbers of patents from all three of the partner organizations. The Licensing and Intellectual Property Management organization is responsible for the interface with TRC.

Presentations at DP Licensing Working Group Meeting

The spring meeting of the Defense Programs Licensing Working Group (DPLWG), hosted by the Westinghouse Savannah River Site, was held in Augusta, GA in April 2004. This meeting provides a forum for Defense Programs laboratories, contractors, and NNSA representatives to discuss licensing and intellectual property issues of mutual interest.

The meeting was attended by representatives from the DOE labs and sites. Sandia presented Quarterly Status Reports for Licensing Metrics, Agreements (Licenses, CRADAs, Work For Others) Funds-In, Commercial License and Income, and Patent Applications, Disclosures and Issuance. Additionally, Kevin McMahon, Manager, Licensing & Intellectual Property Management Department, presented a status update on Sandia’s Royalty Auditing and Compliance and Collections activities.

Vic Chavez Addresses DOC Minority Business Meeting

Vic Chavez, manager of Regional and Small Business Partnering, was invited to speak at the Department of Commerce’s Minority Business Development Agency annual conference which

was held in San Diego in June 2004. His presentation addressed opportunities for Minority Business Enterprises (MBEs) to access Sandia and the various mechanisms available to them.

Sandia Represented at International Partnership for Prosperity Conference

Gary Jones, manager of the Energy & Infrastructure Assurance and Nonproliferation & Assessments Business Development unit, attended the second Partnership for Prosperity Conference held in Guadalajara, Mexico in June 2004 as Sandia’s representative. The meeting focused on U.S. and Mexican government and industry cooperation, and included presentations by U.S. Department of Commerce Secretary Donald L. Evans and Mexico’s President Vicente Fox. During the conference, the Council on Competitiveness met with its Mexican counterpart to discuss a plan for economic development in the Border region through the creation of high-technology clusters. The cluster formation initiative offers partnering opportunities for the Bi-National Sustainability Laboratory (BNSL). The BNSL serves as the necessary commercialization arm of the clusters’ more research and development focus. Debra Wince Smith, President of the Council on Competitiveness, recognized this fit and reiterated her support for the development of the BNSL. The meeting also provided numerous opportunities for positive interactions with Jaime Parada, the Director of CONACyT (Mexico’s Consejo Nacional de Ciencia y Tecnología) and his staff. The meeting was also attended by Paul Shirley, a founding board member of the BNSL, Inc., the non-profit organization that will serve as the entity to bring the BNSL to fruition.

During the conference, the Council on Competitiveness met with its Mexican counterpart to discuss a plan for economic development in the Border region through the creation of high-technology clusters.

RECOGNIZING ACCOMPLISHMENTS AND EXCELLENCE

IN BRIEF

This program provides a strong foundation for high school students in the critical skills areas of mathematics, physics, biology, and chemistry, as well as presenting career opportunities within Sandia, the DP Complex, and the regional microsystems business cluster.

Micro & Nano Education Initiative for Next-Generation Workforce

Micro- and nanosystems interdisciplinary trained technicians and technologists are in short supply. Most are trained in electronics technologies and learn other disciplines and nano/micro-technology-specific tasks on the job. A proposal submitted by Sandia National Laboratories received funding from the National Nuclear Security Administration (NNSA) to support a Microtechnology Academy Initiative. Based on Sandia's successful Advanced Manufacturing for Education model that focuses on developing a pipeline of specifically trained technicians and technologists for advanced manufacturing, this Microtechnology Academy Initiative takes a similar Academy approach.

The Microtechnology Academy Initiative is developing a supply of qualified candidates for essential technical workforce needs in cross-cutting technologies such as top-down nano- and microsystems, which support Sandia's national security mission and economic and workforce development initiatives. This program provides a strong foundation for high school students in the critical skills areas of mathematics, physics, biology, and chemistry, as well as presenting career opportunities within Sandia, the DP Complex, and the regional microsystems business cluster.

Vic Chavez Named FLC Outstanding Lab Representative

At the beginning of FY2004, Vic Chavez was named the 2003 Federal Laboratory Consortium (FLC) outstanding Laboratory Representative. Chavez is the Manager of the Small Business Initiative, New Ventures, Entrepreneurial, Regional Economic Development, Small Business Advocacy, and State of New Mexico Small Business Assistance Programs for Sandia.

The award honors "outstanding achievement" in technology transfer and development by an individual. Vic has been active in the FLC since the early 1990s. He has served in a variety of positions including FLC Mid-Continent Region's Deputy Coordinator and currently as FLC Awards Chair. The FLC news release for the award describes Vic as "a talented negotiator as well as organizer" and goes on to state, "He has been successful in securing state funding that enables small businesses in New Mexico to acquire technical assistance from federal labs. He also has established the first international fuel cell consortium between Russia and the U.S. Chavez was instrumental in establishing the annual Iberoamerican Conference, a collaboration of Portugal, Spain, Central, South and North America. He is responsible for the development and implementation of a training program for aspiring entrepreneurs in which more than 100 individuals have developed spin-off companies as well as implementing a complementary mentor-protégé program for small business suppliers and partners. Chavez has also been inventive in developing active CRADA and licensing programs."

Paper Selected for Special Journal Issue

A paper presented by Kevin Boyack (Computational Biology) and Nabeel Rahal (Licensing and Intellectual Property Management) at the May 2004 Institute for Prospective Technological Studies conference in Seville, Spain was chosen as one of only six conference papers to be included in a special issue of the journal Technological Forecasting and Social Change. The paper, "Evaluation of Laboratory Directed Research and Development Investment Areas at Sandia," describes the use of information visualization tools for identifying and benchmarking Laboratory Directed Research and Development (LDRD)

proposals and projects to identify overlaps and gaps in LDRD investment areas.

Acknowledgment for a Job Well Done

Jennifer Sinsabaugh, in the Office of Advocacy and Small Business Development, received a letter of commendation from Jerry Hanks, Science & Technology advisor to New Mexico Lieutenant Governor Diane Denish. Hanks wrote, "It is my pleasure to write this letter of profound appreciation and thanks to you for supporting technology transfer and business development efforts from Sandia National Laboratories. You have some very happy customers out there ..." He goes on to describe briefly Sinsabaugh's efforts on behalf of Dale Petty Enterprises and the Cumbres-Toltec Scenic Railroad. Jerry concludes by thanking Jennifer for her professional attention to those customers, which brings credit to herself, Sandia, and the Department of Energy.

Licensing and IP Management Audit Yields Clean Result

The Office of Inspector General, DOE, completed an audit of Compliance and Collections within Sandia's Licensing and Intellectual Property Management department in May 2004. The auditors reported in their exit conference that Sandia's policies were consistent with DOE/HQ and the M&O contract. They also stated that the information systems and procedures were good, all of which contributed to the successful audit results and lack of findings.

Partnerships Evaluated by NA-116 and the Sandia Site Office

Sandia's Self-Assessment for Partnerships was presented in a day-long Partnerships Program Review in July 2004 (preparatory to the Performance Evaluation Plans assessment) for DOE/NNSA's Office of Institutional and Joint

Programs and the Sandia Site Office. All aspects of the program were reviewed by NNSA (business development, programmatic management, CRADA processes, IP management, corporate scorecard, customer satisfaction, efficient administration). NNSA complemented the team on the program's maturity, strategy, and quality and rated it as "outstanding."

Student Award Winner

Natasha Bridge, Graduate Student Intern in the Science, Technology, and Engineering Business Development organization, was awarded the Outstanding Administrative Student of the Year award at the Student Internship Program's Annual Symposium. Natasha was selected because of her exceptional initiative, understanding of Sandia's business processes, and high level of customer service.

Sandia Wins Two FLC Awards

The following two technologies were awarded "Outstanding Technology Development" awards by the Federal Laboratory Consortium (FLC) in September 2004 at the FLC Mid-Content Regional Meeting.

"Using Science and Technology to Solve High-Consequence Fire Problems." The Fire Science and Technology Program at Sandia provides solutions to high-consequence fire problems. Experimental and phenomenological fire research and validated modeling tools and capabilities are used to solve problems in fire prevention, fire consequence analysis, and fire mitigation (firefighting). A wide spectrum of computational models are now being developed for phenomena important to fire dynamics (combustion, soot generation, smoke transport, and buoyant turbulent flow) as well as fire suppression (including agent transport and effectiveness). New computer software programs are being

Responding to the tasking from DOE Secretary Spencer Abraham, Sandia has developed the Radioactive Source Registry Tracking System (RSRT), which will track all DOE sealed radioactive sources and provide decision makers with some estimation of the potential threat they may pose.

developed to take advantage of the high speed of computer clusters and massively parallel machines.

“Radioactive Source Registry Tracking System (RSRT).” Small radioactive sealed sources, designed to provide useful tools for measurement and analysis in a variety of industrial and laboratory settings, could potentially be used in radioactive dispersal devices or so-called “dirty bombs.” Responding to the tasking from DOE Secretary Spencer Abraham, Sandia has developed the Radioactive Source Registry Tracking System (RSRT), which will track all DOE sealed radioactive sources and provide decision makers with some estimation of the potential threat they may pose. This project is in coordination with the Nuclear Regulatory Commission and the International Atomic Energy Agency to be consistent with national and international source tracking needs.

Sandia a Leader in Licensing, Technology Innovation, and Commercialization Among DOE's NNSA Labs

Sandia actively supports and pursues strategic intellectual property management. Its professional licensing and intellectual property management function has been vital to successful technology partnerships with industry. Sandia's success in DOE's performance categories demonstrates that those partnerships are an important aspect of Sandia achieving its mission.

DOE was awarded a Licensing Achievement Award by the Licensing Executives Society U.S.A. and Canada (LES) at its 2004 Winter Meeting in San Francisco. The award recognized the Department's pioneering support of technology commercialization through licensing and technology transfer. The Licensing Achievement Award is the highest honor bestowed by LES. It recognizes leading organizations that promote intellectual property commercialization through licensing. Prior recipients of the

award are Stanford University, Pfizer, and IBM Corporation.

DOE's success in technology commercialization depends also on the success of its laboratories in pursuing their mission requirements for technology transfer. Sandia leads the DOE/NNSA labs in most of the licensing and intellectual property performance categories over the past three fiscal years (FY02, FY03, and FY04). In fact, Sandia was ranked first in five of six critical performance measurement categories for three consecutive years. The six critical performance measures are:

- number of new commercial license executed;
- number of active commercial licenses being managed;
- total revenue generated from licenses;
- number of invention disclosures;
- number of patent applications; and
- number of issued patents.

Sandia Partnerships Center Wins AURP Excellence in Tech Transfer Award

The Association of University Research Parks (AURP) has selected Sandia for its 2003 Excellence in Technology Transfer Award. The award specifically honors the outstanding performance of Sandia's Corporate Business Development and Partnerships in conducting a broad-based partnerships program, including several mechanisms for performing R&D with the public sector, intellectual property management and commercialization, innovative small business programs, and the Sandia Science & Technology Park (SS&TP). The award is presented to an individual, agency, and/or program demonstrating exceptional success in transferring technology from a laboratory and nurturing it into viable and growing businesses.

Sandia's record in partnership agreements and business development includes helping hundreds of companies move laboratory-developed technologies

to market. In the small business arena, small and start-up companies have benefited through technical assistance programs and access to Sandia researchers and intellectual property that has strengthened commercial businesses in microelectronics, photonics, lasers, medicine and medical technology, information technology, security, sensors, and software. The SS&TP serves Sandia's industry partners by offering them a location that provides easy access to Sandia's exceptional facilities, technologies, scientists, and engineers. The Park functions as a virtual extension of the Laboratories, providing an ideal location for companies that want to partner with Sandia on technology development or commercialization.

"Best of Best" Award

Congratulations to all the members of the Extreme Ultraviolet Lithography Full-Field Step-Scan System (ETS) team, whose R&D 100 award was singled out for special recognition at the 2004 R&D 100 Awards banquet in Chicago. The editors of R&D magazine said about the ETS achievement: "Dubbed the 'moon shot' of technology in the semiconductor industry, researchers created a sorely needed lithography tool." ETS and two other technologies were singled out at the end of the ceremony for previously unannounced Editor's Choice awards that R&D editors considered to be the most outstanding achievements among the 100 selected. More than 50 Sandians and collaborators from Lawrence Livermore and Lawrence Berkeley national laboratories and industrial partners from Intel, Motorola, AMD, Infineon, IBM, and Micron were honored for this technological advance.

Royalty Awards for Sandia Inventors

More than 250 Sandia National Laboratories personnel earned almost \$660,000 in royalties during the fiscal year ending September 30, 2003. There

were 261 royalty awards, averaging \$795. The highest award was \$84,124. More than \$3.2 million in royalty revenue was generated from 159 licenses related to Sandia enterprises.

Sandia's royalty sharing program gives inventors, authors, contributors, and technical groups in the Labs the opportunity to receive royalties from technology licensing. Technologies receiving royalties included:

- Intelligent software programs that provide reasoning capabilities;
- A software tool to aid in the incorporation of complex gas phase chemical reaction mechanisms into numerical simulations;
- A laboratory chemical detection technique for identifying traces of gunpowder residue left whenever someone fires a gun;
- A valve for fluid control;
- A passive injection control for microfluidic systems; and
- A method to eliminate gas blocking in electrokinetic pumping systems.

Sandia established the royalty awards program to encourage staff and management to identify, protect, and deploy the Labs' intellectual property assets. Such property includes patents, copyrighted software, and trademarks.

Sandia Increases Responsibilities in OFA Processing

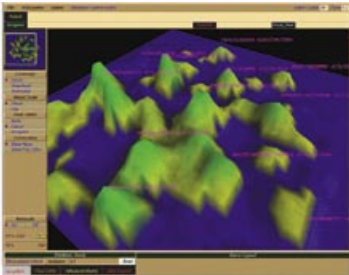
On January 14, 2004, JoAnn Wright, Contracting Officer for the NNSA Sandia Site Office (SSO - vice NA-116), officially requested the support of Sandia in adopting and implementing a new process for accepting Work for Others (WFO) from Other Federal Agencies (OFA). Sandia's Corporate Business Development and Partnerships is now responsible for Sandia's WFO/OFA program, including WFO Interagency Agreement (IA) processing and program oversight.

Sandia's royalty sharing program gives inventors, authors, contributors, and technical groups in the Labs the opportunity to receive royalties from technology licensing.

As a result of NNSA reengineering and reorganization, Sandia assumed responsibility in July 2004 for interfacing with the OFA sponsors to develop high-quality WFO/OFA work authorization packages for SSO review and approval. Previously, NNSA-116 (Albuquerque) had this responsibility. This new policy allows Sandia to build closer ties to OFA sponsors. It will also increase Sandia's partnering workload but could set the stage for assuming greater authority in this and other arenas.

SSO has tasked Sandia with the responsibility of interfacing with OFA sponsors to ensure DOE/NNSA requirements are communicated and met in proposed IAs, and to process IA acceptance packages for SSO review and approval. Processes have been established, resources obtained, staff assigned, files transferred, and communications plan implemented. Effective July 26, official turnover was successfully completed.

Over the past two and a half years, the Corporate Business Development and Partnerships center has led the effort to improve the software suite to return more accurate results and has established a visualization laboratory with large screens and meeting space to enhance communication and the viewing of results. The visualization lab is being used by business developers to identify partnership opportunities and as a tool by the Licensing and Intellectual Property Management department in performance of due diligence.



The Labs' technology is capable of scanning patent databases and scientific journals, as well as the World Wide Web, to produce a variety of 3-D reports.

Visualization Software Supports Partnerships Due Diligence

The New Mexico Business Weekly reported that Sandia is using data mining and visualization software programs originally developed for counter-terrorism to search for patterns in individual companies and industry sectors. Using the programs can be compared to performing a Google search, but with the hits, perhaps thousands of them, displayed as a single 3-D image.

The Labs' technology is capable of scanning patent databases and scientific journals, as well as the World Wide Web, to produce a variety of 3-D reports. For example, users can quickly create a complete visual representation of New Mexico's high-tech patent portfolio. The technology can also track and illustrate patterns, like funding allocations, inside individual companies.

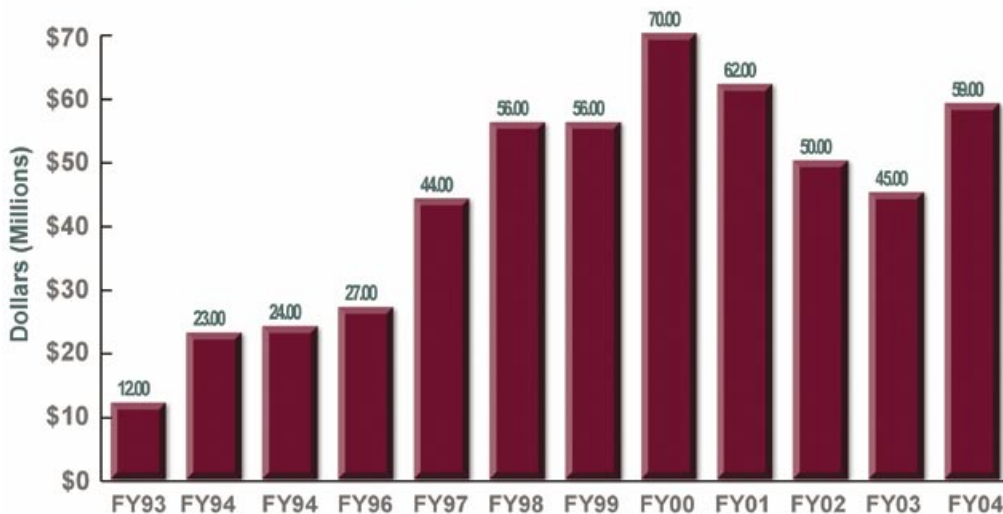
CHARTING PARTNERSHIPS

Like all organizations that have to respect the return on investment for their stakeholders and other constituents, Sandia National Laboratories measures its performance by collecting metrics that indicate progress against its objectives. Sandia is involved in partnerships with industry and OFA customers to support our national security and DOE/NNSA missions, transfer technologies to the commercial sector to improve the competitiveness of US industry, and enhance job creation and small business development. Funds-in to the laboratory are a measure of the value of our intellectual property and capabilities and also provide funds to mature emerging technologies so they are closer to deployment and practical impact.

For FY2004, the metrics show a mixed picture of increasing CRADA activity, funds-in contributions, and patent disclosures, and a decrease in number of WFO/NFE agreements, patent applications and issued patents, and licensing volume.

The charts that follow show the patterns of gains and losses over the course of more than a decade. The trend for all categories studied is decidedly upward, except for the number of CRADAs, a metric that is still in recovery after the Agency's termination of the funded Technology Partnerships Programs of the 1990s.

Industry Funds-in to Sandia



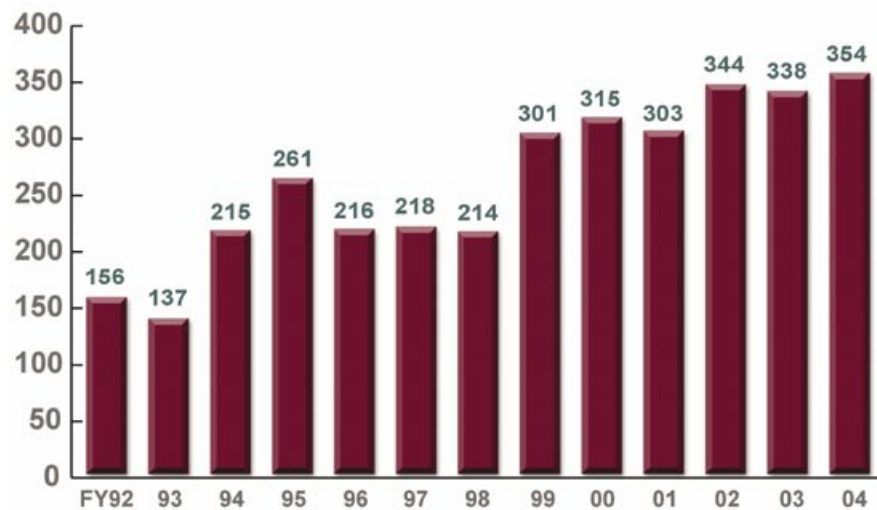
Industry Funds-in

After four years of declining funds-in from industry partners, FY2004 saw an increase of almost 32 percent in partner's cash contributions to CRADAs and WFO/NFE agreements.

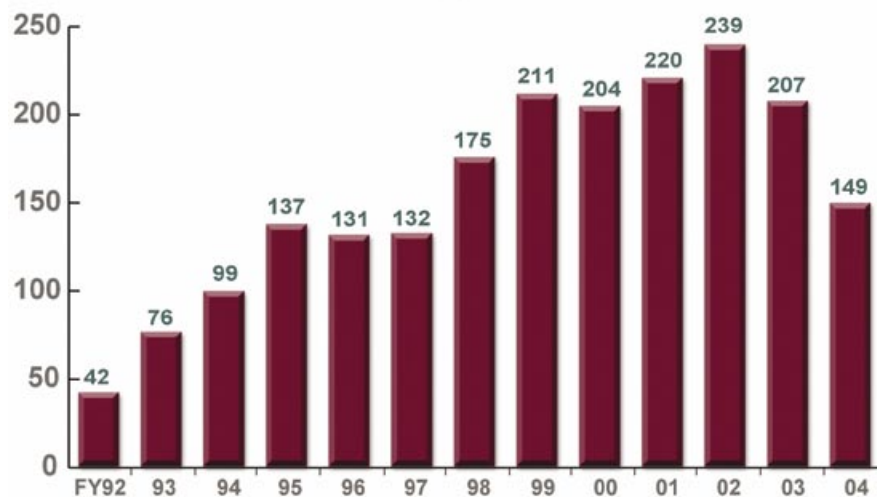
Patents and Disclosures

In FY2004, patent disclosures increased by nearly 10 percent, while applications and issued patents declined.

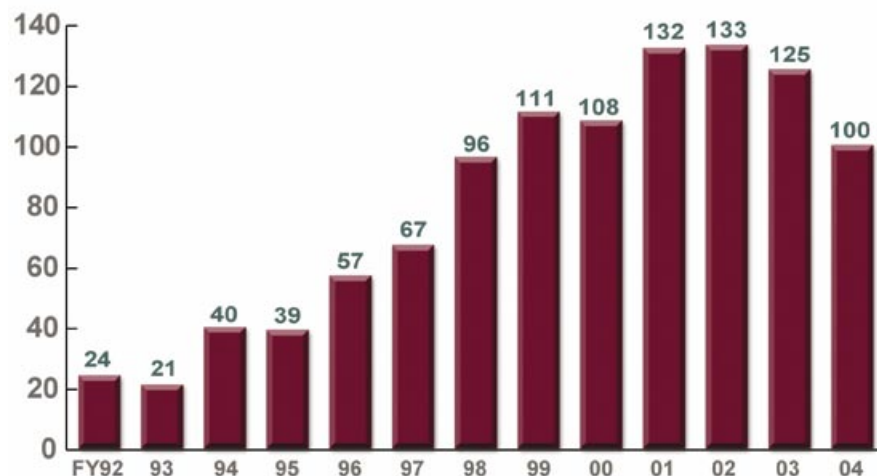
Patent Disclosures



Patent Applications



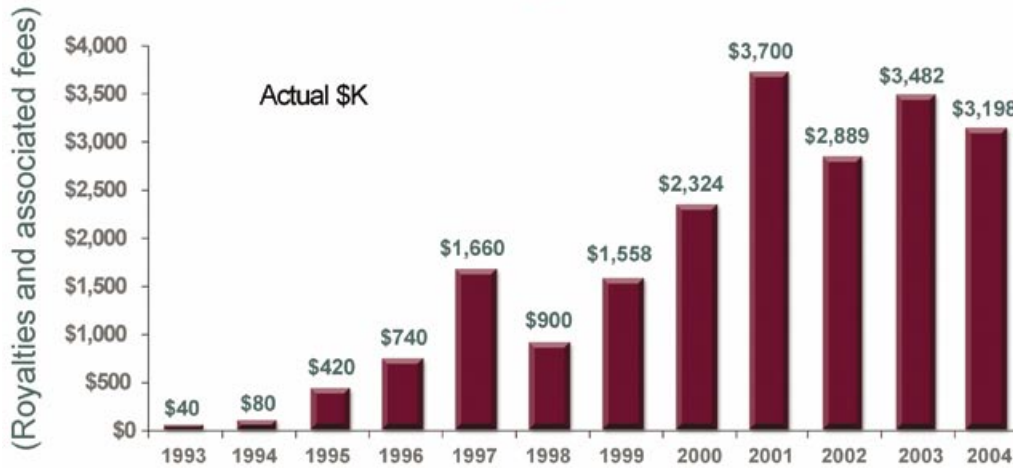
Patents Issued



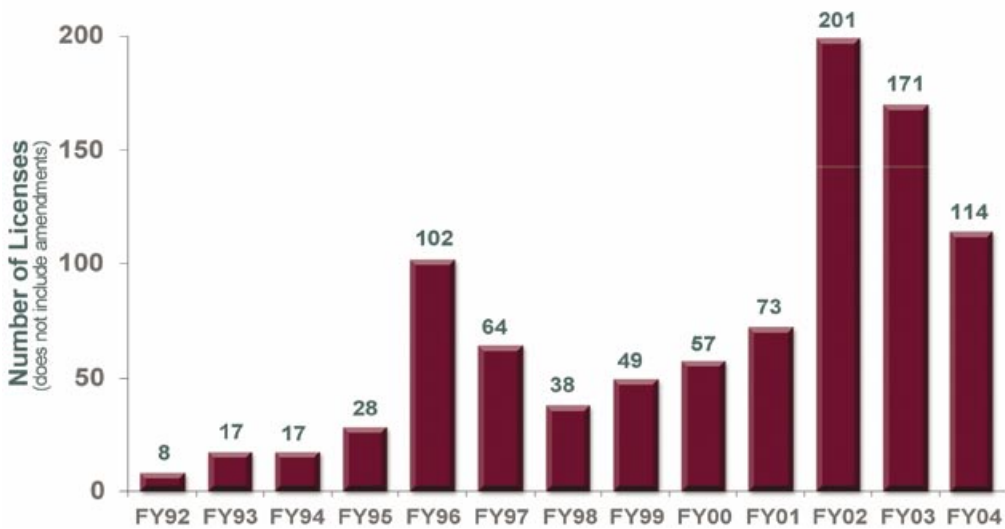
Licensing Income

Licenses

License income has been relatively flat over the last few years despite a decline in the number of executed licenses.



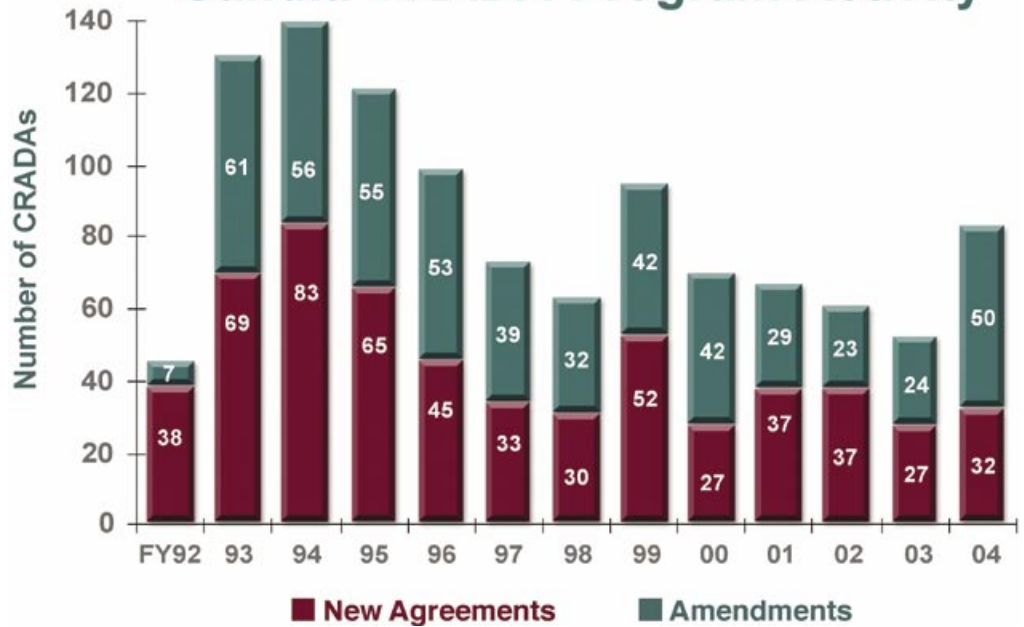
Commercial Licenses



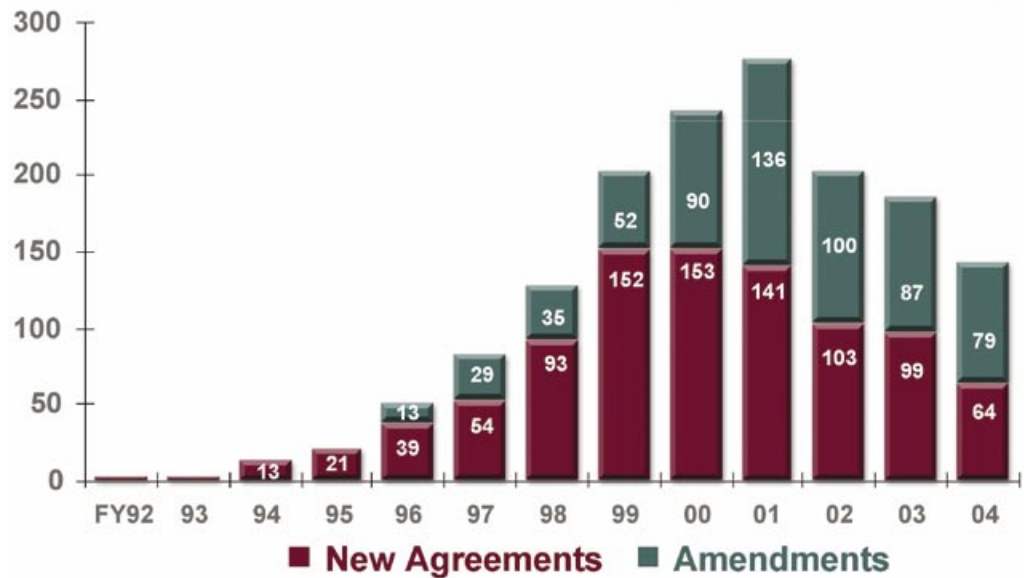
CRADAs and WFO/NFEs

New and amended CRADAs leapt upward in FY2004, more than doubling the number of amendments and edging up in the number of new agreements. WFO/NFE agreements, both new and amended, continued their slow decline.

Sandia CRADA Program Activity



Sandia WFO/NFE Program Activity



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and our community or partners who contributed to this report and to
the continuing success of Sandia's Partnerships program.*



A Department of Energy
National Laboratory



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